# THE USE OF MATHEMATICAL RESOURCES TO TEACH NUMBER CONCEPTS IN THE FOUNDATION PHASE


**by**

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# ABSTRACT

The poor performance of learners in mathematics has long been a matter of concern in South Africa. One certain fact from the Annual National Assessment (ANA) results is that the problem starts in the Foundation Phase (FP) with number concepts. The aim of this study was to explore how five Foundation Phase teachers located in challenging socio-economic school contexts in the Western Cape used mathematical resources to promote teaching for understanding of the important number concept area in CAPS. These resources included humans, materials, culture and time.

The research was located within the interpretive qualitative research paradigm and used a case study approach. The participants in the study included five FP teachers teaching Grades 1 to 3 at two schools in the Western Cape. Data was collected through lesson plan analysis, lesson observations and semi-structured interviews. The data collected was then analysed through the lens of Vygotsky's socio-cultural theory. Socio-cultural theory maintains that knowledge is best acquired if it is mediated by language, more knowledgeable others and physical tools. Vygotsky believed that knowledge is first acquired interpersonally, then intrapersonally, as learners first learn from others, then internalise or individualise knowledge while going through the four stages of the Zone of Proximal Development (ZPD).

The findings of this study revealed that teaching for understanding was often compromised by teaching to enable learners to pass assessments. Teachers understood the importance of using resources to teach number concepts in the Foundation Phase, but inclined to rote teaching with work drills in preparation for assessments such as the Annual National Assessment (ANA) and the systemic assessment. Resources were often used when learners struggled to understand concepts and as calculation tools.

This study supports the view from the literature that the way in which resources are used affects the teaching and learning of number concepts. It recommends that teachers should read and follow the CAPS mathematics document, as it clearly states what resources to use and how. This study further recommends that more research on the use of resources to teach mathematics in other content areas should be done.

## DECLARATION

I, Lindiwe Mntunjani, declare that the contents of this dissertation/thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

…………………………. …………………………

Signed Date

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## DEDICATION

I would like to dedicate this thesis to my daughters Khanyisile and Lisakhanya Mntunjani, who have been with me every step of the way, sitting outside CPUT offices waiting for their mom when there was no one to look after them. I truly hope I have planted a seed, a love for education in them.

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## KEY WORDS

Foundation Phase teachers

Use of mathematical resources

Number concepts

Socio-cultural theory

Social interactions

Zone of proximal development

More knowledgeable other

## ABBREVIATIONS

| | |
|---|---|
| FP | oundation Phase |
| ANA | Annual National Assessment |
| CAPS | Curriculum Assessment Policy Statement |
| CDE | Centre for Development and Enterprise |
| DoBE | Department of Basic Education |
| MKO | More knowledgeable others |
| NCTM | National Council of Teachers of Mathematics |
| TIMSS | Trends in International Mathematics and Science Study |
| LOTL | Language of teaching and learning |
| LTSM | Learner-teacher support material |
| WCF | World Economic Forum |
| ZPD | Zone of Proximal Development |

# CHAPTER 1
# BACKGROUND, PROBLEM STATEMENT AND OBJECTIVES OF THE RESEARCH

## 1.1 INTRODUCTION

This study critically examines the use of mathematical resources to teach number concepts in the Foundation Phase classes of 2 schools in an area in the Western Cape.

Chapter one introduces and discusses the background of the research, the research problem, the aim of and rationale for the research, and the structure of the thesis.

## 1.2 BACKGROUND OF THE STUDY

The use of systemic tests and ANAs to measure learners' performance in Mathematics and Home Language has put pressure on teachers to reflect on their teaching strategies and look for ways to ensure that all their learners are being taught effectively. This problem is not unique to South Africa. The National Research Council of the United States argues that the nature of assessments over the years has changed. Concerns about computational literacy, have led many states to implement minimum competency programs or tests (Weiss, Knapp, Hollweg & Burrill, 2001:59). Policy makers have turned to assessments, as a way to improve education (Weiss et al., 2001:66). However, there is a great concern about these assessments or tests. Weiss et al. (2001:59) argues that:

> "Large scale, high stakes tests can produce unintended effects. When rewards and consequences are attached to test performance, high scores may become the classroom focus. There's a great concern globally, whether teachers are teaching the underlying standards-based content or simply teaching to test".

The MA, ATM and NANAMIC supports the above view. They conducted a survey in search of teachers' views on the impact of assessment on learning and teaching.

The main concern that emerged from their small survey was a deep concern about the pressures that make it very challenging to resist ‘teaching to the test’ (Association of teachers of mathematics for mathematics educators, primary, secondary and higher (ATM), 2007). Furthermore, the study revealed that teaching to test

> “focuses on short term goals and learning that is preoccupied with a narrow range of skills. This is to the detriment of longer term aims such as developing understanding, providing opportunities for skills and knowledge to be applied in a wide variety of ways, encouraging enjoyment and positive attitudes and providing a broader education which embraces but goes beyond the immediate requirements of the specified curriculum. Teachers find it increasingly difficult to be innovative and teach in ways which generate interest and enthusiasm amongst their students, and students are neither well prepared for the needs of employment and everyday life nor for further study of mathematics”.

This removes quality in teaching, leaving learners unable to apply the knowledge learnt and to explore as they should. In this study, I looked at teachers’ use of resources in teaching number concepts. As a Foundation Phase teacher I have always understood the importance of using mathematical resources to support learning in the classroom. I am aware that teaching children mathematics is a step-by-step process which requires the selection of appropriate resources to support every concept taught. This is corroborated by many researchers who believe that concrete materials help learners to learn mathematics concepts (Van de Walle, 2007; Paparistodemou, Potari & Pitta-Pantanzi, 2014:3; Drews, 2007:20). Working with concrete materials helps to enable learners to make abstract concepts concrete and improves performance on mathematical tasks (Martin, Lukong & Reaves, 2007:2).

The availability and use of mathematical resources should be matched by a good understanding of how and when these resources should be used, as different resources serve different functions at different times and in different grades (Mtetwa, 2005:255). For example, flard cards are sometimes used for calculation when their primary purpose is to support the learning of place value (CAPS, 2011:247). Another example is that of number lines and number tracks. It has been found that most teachers use number tracks and not number lines in Foundation Phase classrooms

(Iannone, 2006:10). Iannone (2006:10) finds this problematic and argues that the use of number tracks alone limits learners' understanding of numbers and portrays a number system as made up only of cardinal numbers, leaving no space for fractions and irrational numbers. Number lines, on the other hand, broaden learners' understanding of the number system as they support the learning of different types of numbers. Thus it is essential for each Foundation Phase class to have and use number lines so that learners can have a better understanding of numbers from an early age.

The persistence of poor mathematics results at the school at which I was teaching led me to question how resources were being utilised to support the learning of number concepts. I looked at resource related challenges that Foundation Phase teachers experienced when teaching number concept, Foundation Phase teachers' perceptions pertaining to the importance of using resources when teaching number concept and how Foundation Phase teachers use resources when teaching number concept. I was interested to find out how the basis for mathematics learning was laid in the Foundation Phase. Of particular interest was to find out how number concepts were taught in this phase, as it is the basis for all other concepts. Number concepts (which include computation) are an important part of mathematics, and proficiency in this area has long been one of the main objectives of teaching and learning mathematics in both school and university (Engelbrecht, Bergsten & Kågesten, 2009:928).

There are five content areas to be covered in the Foundation Phase, as stipulated in the Mathematics Curriculum and Assessment Policy Statement (CAPS) (2011:10-11): (i) number, operations and relationships; (ii) patterns, functions and algebra; (iii) space and shape; (iv) measurement, and (v) data handling. This study only focused on content area number (i), number, operations and relationships. This content area is the main focus in the Foundation Phase (CAPS, 2011:12). It weighs more than 50% in all Grades. In Grade 1 it weighs 65%, Grade 2, 60%, and in Grade 3, 58%. I also believe that this content area is the basis for all the other content areas, and if it is taught and understood well, learners' chances of success in other content areas are high. Locuniak and Jordan (2008:453) agree that number concept and working memory in the Foundation Phase would be a strong predictor of later fluency in calculation. This content area is broken down into 17 mathematical topics:

1.1 Count objects
1.2 Count forwards and backwards
1.3 Number symbols and number names
1.4 Describe, compare and order numbers
1.5 Place value
1.6 Problem solving techniques
1.7 Addition and subtraction
1.8 Repeated addition leading to multiplication
1.9 Grouping and sharing leading to division
1.10 Sharing leading to fractions
1.11 Money

**Context-free calculations**

1.12 Techniques (methods or strategies**)**
1.13 addition and subtraction
1.14 Repeated addition leading to multiplication
1.15 Division
1.16 Mental mathematics
1.17 Fractions

## 1.3 AIM OF THE RESEARCH

The aim of this research was to investigate Foundation Phase teachers' use of various mathematical resources in teaching number concepts in one district of Cape Town in the Western Cape. Of particular interest was the question of how these resources were used to promote understanding and support the learning of number concepts. The study looked at the use of counters, bead strings, abacuses, base ten blocks, number lines, number charts, number tracks (see figure 1) and DoBE rainbow work books, as these are both the most commonly found and recommended in CAPS (CAPS, 2011:246-27).

## 1.4 RESEARCH QUESTION AND SUB-QUESTIONS

This research attempts to answer the following research question and sub-headings during analysis of the data collected. How do five Foundation Phase teachers located in challenging socio-economic school contexts in the Western Cape use mathematical resources to promote teaching for understanding of the important number concept area in CAPS?

- What are the resource related challenges that these Foundation Phase teachers experience when teaching number concept?
- What are these Foundation Phase teachers' perceptions pertaining to the importance of using resources when teaching number concept?
- How do these Foundation Phase teachers use resources when teaching number concept?

## 1.5 RATIONALE FOR THIS STUDY

The poor performance of South African learners in mathematics is a major concern (Siyepu, 2013:1). My particular concern with the mathematics results at the school at which I taught, and my quest to improve these, led to this research. I believe that mathematics can be best taught if a sound basis is laid early on in the Foundation Phase. If learners leave the Foundation Phase with a strong understanding of number concepts, then building on that knowledge and applying it in problem solving will be much easier and more successful.

One of the factors contributing to poor mathematics results may be the lack of appropriate resources for learning (Ndlovu, 2012). But the question of how resources are used is just as important. The success of learners in mathematics is largely dependent on the quality of teaching and the skill of the teacher. "The person who is the key to providing a quality mathematics programme for early childhood learning is the classroom teacher" (Paparistodemou, Potari & Pitta-Pantanzi, 2014:2). The way in which teachers teach mathematics is important and should be informed by how learners learn. In the Foundation Phase various resources are supposed to be used to ensure the effective teaching and understanding of number concepts. The aim of my research was thus to find out how mathematical resources were being used to teach number concepts and promote understanding in classrooms. I also want to know the following: What are the resource related challenges that the selected Foundation Phase teachers experience when teaching number concept? What are these Foundation Phase teachers' perceptions pertaining to the importance of using resources when teaching number concept?

## 1.6 RESEARCH PROBLEM

After 4 years of teaching as a Foundation Phase teacher at a school in the Western Cape, I had become aware that learners were experiencing challenges with mathematics. In the Foundation Phase, the most common problem was that learners did not seem to have a real understanding of number concepts. It seemed that learners were mostly taught and learned by rote. The problem with rote learning is that it does not necessarily enhance understanding, but relies upon procedure and memorising, which make it difficult for many learners to apply the knowledge (Engelbrecht, Bergsten & Kågesten, 2009:927). Most learners tended to perform fairly well in tests set by their own teachers. However, the same learners would perform poorly in tests set by other teachers or under the supervision of other teachers, on the same mathematics content. This appeared to indicate both a lack of confidence and an inability to transfer and apply knowledge in different domains.

Findings based on the results obtained from the Western Cape Education Department (WCED) from the systemic mathematics and English evaluation in Grade 3 and Grade 6, conducted every year in September between 2010 and 2013, revealed that the learners at the school at which I taught performed poorly in mathematics. Less than 50 % of the Grade 3 and Grade 6 learners obtained a pass rate of 50% for mathematics in the years 2010 to 2013. This meant that the teaching methods being used were not producing the required results.

## 1.7 STRUCTURE OF THE THESIS

The thesis is divided into six chapters.

**Chapter one** explains the rationale and purpose of the study, discusses the research problem and gives an outline of the thesis.

**Chapter two** provides a review of the literature pertaining to the use of mathematics resources in the foundation phase, as well as the poor performance of learners in mathematics and the possible reasons for this.

**Chapter three** describes the theoretical framework of the research, focusing on Vygotsky's sociocultural theory.

**Chapter four** outlines the research methods used in this study. This includes coverage of the interpretive qualitative paradigm, the target group, the context of the study, methods of data collection and how the issues of reliability and validity were addressed. It also discusses data analysis, triangulation and research ethics.
**Chapter five** presents the findings and discusses them.

**Chapter six** includes a summary of the results in relation to the research question and research framework. Chapter six also discusses the significance and the limitations of the study. In conclusion, it makes recommendations and suggests avenues for further research.

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 INTRODUCTION

This chapter deals with literature relevant to the topic of the research. It first discusses the poor performance of learners in mathematics, then goes on to describe the use of resources to teach number concepts and how they can enhance learners' understanding of number concepts. Resources include humans, materials, culture and time. The section on resources ends with discussion of the ineffective use of resources. This is followed by a discussion on how children learn number concepts. The chapter concludes with a summary.

## 2.2 POOR PERFORMANCE OF LEANERS IN MATHEMATICS IN A SOUTH AFRICAN CONTEXT

This section examines the poor performance of learners in mathematics in a South African context. "South Africa has the worst education system of all middle-income countries that participate in cross-national assessments of educational achievement" (Spaull, 2013:3). In 2012 The World Economic Forum (WEF) identified the quality of mathematics in South African education as the lowest out of 62 countries (Wallace, 2013). Evidence shows that South Africa continues to perform worse in mathematics than many low-income African countries. The Trends in International Mathematics and Science Study (TIMSS) also shows that South African learners perform poorly when compared to other participating countries (TIMSS, 2011). It is clear that there is a continuing crisis in South African education "and that the present system is failing most of South Africa's learners" (Spaull, 2013:3).

There are important reasons for placing emphasis on assessing and improving mathematics results (Wallace, 2013). The performance of a country in mathematics and science affects the country's economic growth and points to the quality of the human capital pool. Mathematics plays an important role in determining learners' success or failure as citizens (Ndlovu, 2011:420). Society views mathematics as the foundation of the scientific and technological knowledge that is crucial for the social and economic development of a nation (Mbugua, Kibet, Muthaa, & Nkonke, 2012:87). This makes mathematics one of the most important school subjects in the curriculum worldwide and a compulsory subject in primary and secondary schools in most countries (Mbugua et al., 2012: 87). Currently, South Africa has to import much of the scientific and technological expertise that is essential for its economic development (Makgato & Mji, 2006). The country is in dire need of appropriately qualified mathematics teachers and the current education system will not be able to produce sufficient numbers of students qualified to go into this field of study (Makgato & Mji, 2006:254).

To address these issues and improve the quality of basic education, the South African Department of Basic Education (DoBE) introduced the Annual National Assessment (ANA) (DoBE, 2014). The ANA comprises standardised assessments aimed to measure and improve learners' performance in mathematics and home language from Grade 1 to 6 and Grade 9 (South Africa. Department of Basic Education, 2014:14). Similarly to the systemic evaluation, the ANA results "are used to report on the policy goals of access, equity and quality as indicators of the 'health' of the education system [and] targets a more diagnostic interpretation of learner achievement" (South Africa. Department of Basic Education, 2014:14). Spaull (2013:3) argues that these tests are important in improving the quality of education in South Africa, but the fact that they are invigilated and marked by the learners' own teachers and lack external verification reduces their value. Table 2.1 shows the average mark achieved by learners for the ANA from 2012 to 2014 in South Africa.

Table 2.1 ANA learner average mark from 2012 - 2014

| **Grade** | **MATHEMATICS AVERAGE PERCENTAGE MARK** | | |
|---|---|---|---|
| | **2012** | **2013** | **2014** |
| 1 | 60 | 60 | 68 |
| 2 | 57 | 59 | 62 |
| 3 | 41 | 53 | 56 |

The ANA has helped teachers to identify areas in which learners experience challenges. Table 2.1 shows that there has been an annual improvement in learners' performance. An analysis of learners' responses in the ANA 2013 led to the creation of "the 2013 Diagnostic Report and 2014 Framework for Improvement" (DoBE, 2014:18). This report suggested strategies for improvement and revealed that some of the challenges faced were caused by ineffective teaching methods (DoBE, 2014:19). However, there are several factors that contribute to learners' performance in mathematics, and to know what these factors are is important if teachers are to improve this performance.

### 2.2.1 Factors that contribute to learners' poor performance

There are many factors that may be contributing to the continually poor mathematics results in South Africa. One certain fact emerging from the ANA results is that the problem does not start in the higher grades when one analyses table 2.1. It starts in the Foundation Phase. Thereafter, learners' performance deteriorates as they progress from lower grades to higher grades. Table 2.1 shows that the results decline from grade to grade in the Foundation Phase. Posthuma (2015) agrees that there is a need for intervention in the Foundation Phase. This is confirmed by the poor performance of Grade 3 learners in the ANA in 2010, achieving an average mark of 28%; in 2011 only 17% achieved 50% and in 2012, 37% achieved 50% (Posthuma, 2015). Spaull (2013:3) suggests that inequality plays a huge role in the performance of learners in mathematics. He points out that:

> the analysis of every South African database of educational achievement shows that there are two different public school systems in South Africa. The smaller, better performing system accommodates the wealthiest 20-25 % of pupils who achieve much higher scores than the larger system which caters for the poorest 75-80 % of pupils. These two systems can be seen when splitting pupils by wealth, socio-economic status, geographic location and language (Spaull, 2013:3).

Ndlovu (2011:419) agrees that even findings by the Centre for Development and Enterprise (CDE) suggest that South Africa relies on just more than 400 of its top schools for half of its mathematics passes at the 50% level and 350 schools for half of its science passes at the 50% level, out of a total of 5903 schools nationally. The great majority of South African learners struggle to read, write and calculate at correct grade level, with many being functionally illiterate and innumerate. The wealthy minority are an exception (Spaull 2013:3). According to Mbugua, Kibet, Muthaa & Nkonke (2012: 90), poor academic achievement may also be the result of low socio-economic status. It is believed that “low socio-academic status is associated with limited resources thus lower academic achievement” (Mbugua, et al., 2012:90). This shows that even though South Africa is a democratic country, education is still not equal. Learners are not given the same quality of education throughout the country. This study looked at schools with low socio-economic status, investigating what resources are available for them to use to teach mathematics and how they use the available resources to teach number concepts and to promote understanding.

Spaull (2013:4) argues that for disadvantaged learners, there are increasing gaps between what they should know and what they do know. Mbugua et al. (2012: 90) argue that the educational background of learners’ parents and guardians can make an important contribution to minimising such gaps and to the learners’ success in school. They found that most learners’ parents do not have education beyond secondary level. These low levels of education make it difficult for parents to help their children in school activities such as homework, assignments and projects (Mbugua et al., 2012). These factors contribute to gaps becoming bigger as time passes, leaving learners further behind in the curriculum and making it difficult for them to cope in secondary school. Despite this, as Ndlovu (2011:420) argues, very little is being done to find out what underpins the high pass rates in well-resourced or top-performing schools.

Another complication may lie in the way in which the education system measures the functionality of a school (Ndlovu, 2011:420). Mbugua et al. (2012: 87) conducted a study in Kenya to determine factors that might be affecting learners’ performance in mathematics in secondary schools. They found that looking at learners’ entry marks to secondary schools from primary schools revealed no reason for their poor performance in mathematics, as these marks were between 200 and 400 out of a maximum of 500. Measuring a school’s functionality according to percentage passes in mathematics and science as opposed to the quality of education being provided can cause more complications (Ndlovu, 2011:420). Ndlovu (2011:420) suggests that this type of measurement has created tension and discouraged many learners from studying mathematics at advanced levels.

Mbugua et al. (2012: 87) found that the workload of mathematics teachers might also affect the quality of teaching. They found that some of the teachers used the “lecture method” to teach as this method is not time consuming and covers greater content. But the lecture method is not effective because it does not encourage learners to actively participate in the process of learning (Mbugua et al., 2012:87). The use of outdated teaching methods and lack of content knowledge have also contributed largely to the poor mathematics results (Makgato & Mji, 2006:254). Posthuma (2015) adds that teachers themselves often make the same mistakes as learners, which shows that they urgently need in-service training and development to become more competent in their jobs. There are no specific knowledge or practice standards that are defined as guidelines for the development of programmes for preparation of teachers in all phases and subjects in South Africa. South African universities that offer Foundation Phase teacher training develop their own curriculum for the preparation of Foundation Phase teachers in mathematics (Posthuma, 2015). Posthuma (2015) finds this problematic because the quality of teachers’ training might not be the same and they might not all be equally well prepared.

This study deals with the use of resources to teach number concepts, which play an important role in determining the quality of education (Ndlovu, 2011). The focus is on the Foundation Phase as the basis of the entire schooling system and the place where gaps in mathematics knowledge start to develop. It is of paramount importance for the “learners’ future schooling to have developed a solid foundation of basic understanding and skills across the core subject areas by the early grades” (Mullis, 2011:13). Learners performing below the required standard may be at risk for future success in their educational careers, and may fall further and further behind their peers as they continue in school (Mullis, 2011:13). This suggests that the earlier the problems are addressed, the better are the chances for future success for learners.

## 2.3 RESOURCES IN A MATHEMATICS CLASSROOM

This section deals with the different types of resources in a mathematical classroom. The term ‘resources’ goes beyond material objects (Adler, 2000) and includes human, material, cultural and time-related resources. ‘Mathematical resource’ refers to any form of mathematical apparatus (structured or unstructured), image, information and communications technology (ICT), game, tool, paper, or everyday material which could be used to teach a mathematical lesson or serve as a learning aid (Drews, 2007).

### 2.3.1 Human resources in a mathematics classroom

Human resources in a mathematics classroom include teachers, parents and learners, but of these mathematics teachers play the most crucial role (Adler, 2000). Mathematics teachers are trained and entrusted to facilitate teaching and learning in the classroom. Their qualifications and skills comprise an important resource in educating learners. The number of learners in their classrooms and parental involvement influences the teachers’ ability to be resourceful (Adler, 2000).

Intrigued by the extent to which Chinese students outperformed American students in international comparisons of mathematics competency, Ma (2007) conducted a study which revealed that the more knowledgeable other plays a vital role in the success of learners. In the case of Ma’s study, the more knowledgeable others were the teachers and it was evident in Ma’s study that their teaching approaches influenced and determined the learners’ success in mathematics. Makgato and Mji (2006) agree that among many other reasons, South Africa’s poor results in mathematics can be ascribed to underqualified mathematics teachers, their use of outdated teaching methods, their lack of basic content knowledge and their having to teach in overcrowded classrooms.

A significant percentage of a teacher’s effectiveness lies in the ability to design and implement teaching that promotes learning (Centre for Excellence in Teaching, 1999:29). A lesson plan, which can be defined as a detailed blueprint of the goals and activities for a specific class, is a central part of this process. Drawing up a lesson plan entails considering how to organise material in order to achieve the goals and objectives recommended for the course (Centre for Excellence in Teaching, 1999:29). In this regard, CET (1999:32) advises that a teacher should:

- Be flexible and not adhere to the lesson plan rigidly because a lesson plan is simply a guide. Valuable learning opportunities will be missed if teachers fail to make adjustments based on how the class is learning.
- Have alternative plans. The lesson might not go as planned and necessary adjustments will need to be made. When planning, leave room for one or two possible scenarios and be prepared with alternative plans.
- Find a lesson plan format that is comfortable for oneself because teachers are all different.

Teachers should provide experiences through which learners will be able to develop and build connections (Van De Walle, Karp & Bay-Williams, 2010:26). In the present context, this means that "Foundation Phase teachers should actively introduce mathematical concepts, methods and language through a variety of appropriate experiences and research-based teaching strategies" (NCTM, 2013:1). Mtetwa (2005:255) asserts that improvement of the quality of teaching is the responsibility of teachers. Teachers need to understand what they are currently doing in their classrooms through deliberate and serious observation of and reflection on their own current practice, as there is always more to learn about the content and methods of teaching mathematics. Van De Walle et al. (2010:23) concur that:
The ability to examine oneself for areas that need improvement or to reflect successes and challenges is crucial for growth and development. Best teachers try to improve their practice through reading latest articles, newest books, attending conferences and reading conference proceedings.

Schoenfeld and Kilpatrick (2008:1) argue that in order to improve mathematics teaching, one has to first find out and understand what the dimensions of proficient teaching are. Furthermore, one needs to find a workable theory of proficiency in teaching mathematics that could be used to guide the selection and use of tools for mathematics teacher education. Proficient teachers possess knowledge of school mathematics that is both broad and deep (Schoenfeld & Kilpatrick, 2008:1). Teachers should have both subject matter content knowledge and pedagogical content knowledge (Borko et al., 1992:196). Borko et al. maintain that teachers with broad knowledge have various ways of conceptualising the current grade-level content, can represent it in a variety of ways, understand the key aspects of each content area, and see connections with other content areas at the same level (Borko et al., 1992:196). Their knowledge is deep in that they know the origins of the curriculum and the direction of its content.

### 2.3.2 Material resources in a mathematical classroom

There is a wide range of material resources in mathematical classrooms, and these can be grouped into three types (Adler, 2000). There are (i) school mathematics materials, (ii) mathematical objects and (iii) everyday objects. School mathematics materials are materials made specifically for school mathematics like chalkboards, computers and textbooks. Mathematical objects refer to resources that arise in the context of the discipline, like a number line and Dienes blocks. Everyday objects include money and bottle tops which have no direct relation to the mathematics classroom.

The use of material resources for teaching and learning has been a standard practice for many years among primary school teachers, especially in the Foundation Phase (Drews, 2007:19). Allied to material resources are teaching and learning resources, like textbooks, videos, software, and other tools that teachers use to support learners to meet the learning outcomes recommended by the curriculum (British Columbia: n.d.). Lesser and Pearl (2008:2) claim that “teaching and learning resources are fun materials used to teach”. While neuropsychologists believe that humans are born with “number sense, or an innate ability to perceive, process, and manipulate numbers”, this ability needs to be fostered through the extensive use of visual resources (Abramovitz, 2012:2).

Teaching and learning resources in a Foundation Phase mathematics classroom are not just concrete materials, but can range from concrete to semi-concrete to abstract materials. It is through the activity of manipulating these resources and the resultant experiences that learners are given opportunities to make connections (Drews, 2007:19). Boggan, Harper and Whitmire (2010:2) agree that “it is important for children to have a variety of materials to manipulate and the opportunity to sort, classify, weigh, stack and explore if they are to construct mathematical knowledge”. Martin, Lukong and Reaves (2007:1) refer to concrete materials as “manipulatives”. They define manipulatives as “hands-on objects” that help learners to learn mathematics better. In sociocultural theory, resources are often referred to as ‘‘mediational means or cultural tools’’ (Furberg & Arnseth, 2009:157). Bornman and Rose (2010:82) add that mathematical resources are visual tools that help learners understand what is being taught or asked. They further explain that visual tools can be real objects, pictures or drawings that are used by teachers to help learners solve mathematical problems (Bornman & Rose, 2010:82). Crafter (2012:34) says that “resource is a concept that refers to the way in which the individual is simultaneously a seeker and provider of meaning. The classical definition of a resource suggests that it is any object which one resorts to for aid or support”.

The primary purpose of resources is to assist children to make abstract concepts concrete (Nishida, 2007:1). Drews (2007:19) agrees that resources assist in the storage of mental pictures. In the early stages children are merely memorising numbers and matching their representation as numerals to their spoken names (Anghileri, 2007).

In order for learners to be able to compute using the four basic operations, they must first have established basic concepts including more, less, many, one-to-one correspondence with real objects, the concept of sets and basic number sense (Abramovitz, 2012). Mathematics by its very nature is abstract and additional effort is essential to enable learners to understand its concepts, principles and applications (Ojimba, 2013:47). Furthermore, “many principles and concepts in mathematics are not simply explained with common sense deduction”, which makes it even more difficult for learners to understand mathematics (Ojimba, 2013:47).

The value of practical resources lies in their enabling learners to create and store pictures in their minds. This means that engagement with any resource needs to be internalised through mental imaging so that learners can use images even in absence of resources to solve future mathematical problems (Drews, 2007:20). Boggan et al. (2010:2) add that mathematical tools can be used at any grade to introduce, practice, or even remediate a mathematics concept. It is important for learners to see mathematics, and the calculations that they perform, as part of their daily life. Providing opportunities to apply basic concepts and operations in daily activities reinforces learners' skills and motivates them to progress in mathematics (Abramovitz, 2012).

The use of pictures in mathematics texts has become an important educational tool and part of a growing interest in notational systems used to present or represent ideas for others and for ourselves. Textbooks and workbooks such as the blue books (Department of Basic Education) are being used for visualisation to achieve clarity and focus (Yerushalmy, 2005:217). Yerushalmy (2005:217) explains that visual language in mathematics can become a resource for activities that promote new ideas and thinking. Visual language refers to the use of words and pictures within the defined shapes and structures, communicating through visual elements (Benn & Benn, 1998). Visual language can be used to simplify challenging ideas, demonstrate deeper meaning or support collaborative thinking (Benn & Benn, 1998). The ability to extract only the important information from a visual tool is necessary for further reasoning about the mathematical object in question. This is a valuable skill for mathematics. It is a process which fixed paper pictures (semi-abstract) are limited in their ability to promote because "the mathematical structure of the problem situation is not sufficiently apparent to the learners" (Yerushalmy, 2005:217). Ma (2010:5) warns about the shortcomings of Drews's and Anghileri's enthusiasm, pointing out that "using mathematical resources does not guarantee the right destination" – the intended outcome.

Drews (2007:22) advises that learners should be encouraged to use a variety of the same type of resource so that they do not form misconceptions based on experience with limited resources. Learners' ability to use mathematical resources in various ways can stimulate more opportunities for “investigational and collaborative work: such activities are more likely to encourage purposeful mathematical discussion and development of logic and reasoning” (Drews, 2007:22).

The fundamental concern is whether or not teachers understand the value of using mathematical resources to teach number concepts and the rationale behind the use of such resources, as “effective mathematics teaching entails understanding what learners know, what they need to learn and then challenging and supporting them to learn it well” (NCTM, 2000:16).

### 2.3.3 Cultural resources in a mathematics classroom

Language is a cultural and social resource for communication in the classroom (Adler, 2000:211). It includes learners’ home languages and their relation to the language of instruction. It is also a resource that learners use to answer questions and discuss with each other in class.

Language provides a framework for using external speech and internal speech to make meaning of situations (Hines, 2008:4). This statement implies that language is necessary for making meaning. Siyepu and Ralarala (2014:327) agree that proficiency in the language of instruction or Language of Learning and Teaching (LOLT) is a prerequisite for understanding and making sense of the language of mathematics. However, most learners in South Africa are taught mathematics in a language that is not their mother tongue (Siyepu & Ralarala, 2014:327). With English being the dominant language and the language of opportunities, parents who can and want to, enrol their children at schools where English is the LOLT, irrespective of whether they can speak and understand the language. This makes it difficult for learners to access the language of mathematics too, and make sense of the signs, symbols, rules and formulae used (Siyepu & Ralarala, 2014).

Barbu (2010:13-14) also acknowledges that language is important for learning, suggesting that the difficulty experienced by learners in solving mathematical problems might lie in the complexity of the language in which mathematical problems are given. He conducted research hoping to prove that language and the complexity thereof plays a huge role in learners' mathematics achievement. He gave English learners sets of the same mathematical problems but simplified to verify that the complexity of language does indeed play a role in the successful solving of mathematical problems. He found that the learners performed better in the problems that were not linguistically and mathematically challenging (Barbu, 2010:13-14). So language is important as it promotes understanding. Most learners in the Foundation Phase are able to compute when given context-free computations but find it challenging to do the same computations in context.

Killen (2000:25) adds that mathematics has its own special language and learners need to learn and master that language in order to understand the subject. English second language (ESL) learners thus have the double burden of having to learn the LOLT as well as the language of mathematics. Lack of clarity or misunderstanding of symbols inhibits learners from finding the relationship between their existing mathematical knowledge and the new knowledge to be learnt, and this tends to have negative repercussions on their success in mathematics (Siyepu & Ralarala, 2014:328).

In their study, Siyepu and Ralarala (2014: 327) write about their concern for English second language university students struggling and failing to understand mathematics. This problem is exacerbated by the fact that some ESL student teachers and teachers (especially Foundation Phase trained) are not proficient in the language of instruction (English) but were taught mathematics in English. If ESL student teachers struggle to understand mathematics at university level, how much more will they struggle to teach it? “Learning the language of a new discipline is a part of learning the new discipline; the language and learning cannot be separated” (Schleppegrell, 2007:140). Learners start schooling with an understanding of their home language that they use to construct their knowledge of the world. Teachers should therefore use and build on that language and knowledge, moving learners towards new and more scientific and technical understandings by being aware of the linguistic challenges that accompany the conceptual challenges of learning (Schleppegrell, 2007:140).

It is also important for teachers not to assume that by using a word frequently learners will understand it (Killen, 2000:25). Teachers should not even assume that because learners use words, they understand and know them. Schleppegrell (2007:143) agrees that just knowing mathematical words such as more, less, and as many as, is not enough. She says that learners also need to learn the language patterns associated with these words and how they construct concepts in mathematics. Mathematical language is not something that learners will learn automatically, it has to be taught (Killen, 2000:25). Furthermore, the ability to work with language alone is not enough in mathematics. “Mathematics draws on multiple semiotic (meaning creating) systems to construct knowledge: symbols, oral language, written language, and visual representations” – such as concrete, semi-concrete and abstract materials (Schleppegrell, 2007:141). Teachers should therefore use resources together with language to teach learners the language of mathematics, as this is the basis for everything they will need to learn to solve mathematical problems.

### 2.3.4 Time as a resource in a mathematical classroom

Time may be regarded as one of the most valuable resources in a mathematical classroom (Johnson, 2008). Johnson observes that “it is the resource that we often pay the least attention to and end up abusing (wasting) more than any other”. Time functions in schools through time- tables, the length of periods and possibilities for homework (Adler, 2000). Time structures school mathematics lessons to create pacing, sequencing and time-bound tasks. It structures teachers’ work. Johnson points out that teachers have a certain number of days in which to teach their learners and cover the curriculum. He concedes that there are worthwhile activities such as sports that may use up some of that time, as well as minor time wasters that add up, such as “morning announcements, classroom business, learners being summoned to the office, assembly and other classroom interruptions”.

Johnson (2008) argues that the most important aspect of time for teachers is the amount learners spend actively engaged in the learning process, not just the amount they spend on school grounds. He further explains that learners should spend less time listening to teachers and more time being engaged in activities using resources that will help them understand and retain the information. “Knowledge or comprehension-level information and skills are pushed into long-term memory by practice, memorisation, or participation in varied higher-order thinking activities” (Johnson, 2008).

Teaching is a complex task. Teachers tend to feel that there is a lot to do, and only a limited amount of time in which to do it (Francis, 2008). How teachers and schools spend their time is the critical issue in establishing urgency.

### 2.3.5 Ineffective use of resources

The selection and effective use of appropriate mathematical resources requires careful consideration and planning on the part of the teacher (Drews, 2007:21). The mere use of manipulatives does not mean that desired outcomes such as promoting understanding and enhancing knowledge of mathematical concepts will be achieved. Mathematics is not just about completing sets of exercises or following processes that the teacher explains, but rather generating strategies for solving problems, applying those strategies to help solve problems and checking to see whether the answers make sense. As Van de Walle et al. (2014:12) assert, “mathematics in the classroom should closely model how mathematics is done and used in the real world”.

Many Foundation Phase classrooms employ mathematical resources such as number charts, number lines and counters. These mathematical resources are designed to represent mathematical concepts. However, it is not always easy for young children to connect concrete objects such as blocks, beans, and sticks, with mathematical concepts (Paek, 2012:2): Imagine that there are white blocks, each of them having a length of one unit, and orange blocks, each having a length of ten units, on the same scale, and that the addition problem, 6+7, is given to a child to solve with these blocks. The child has to collect six white blocks, and again seven white blocks. Once the blocks are collected, they can be put together. When the length of the collected white blocks equals that of an orange block, the ten white blocks are replaced by one orange block. The teacher's intention with this activity is to teach the concepts of addition and place value using concrete materials. However, for young learners, the activity might be a simple colouring exercise, replacing blocks according to their colour. Young learners might not be aware why they are exchanging the ten white blocks for the single orange block, while still following the directions correctly step-by-step. In this situation, the activity becomes simply procedural, which is a commonly perceived problem with manipulatives (Paek, 2012:2).

Resources such as those mentioned above have been shown to be effective in supporting the learning of number concepts such as addition, subtraction, multiplication, division, and problem solving in various contexts (see figure 2.1). However, as already suggested, the use of these resources does not necessarily mean that constructive learning is taking place, as resources may not be used optimally (Van de Walle et al., 2010:29). The ineffective use of resources often happens when teachers "tell learners exactly what to do and how to use the resources" (Van de Walle et al., 2010:29). This teaching style does not promote understanding so much as rote learning.

Van de Walle et al. (2010:29) thus caution against "the natural temptation by teachers to take out the materials and showing children exactly how to use them". Although learners need the direction of teachers in using resources, too much directing from teachers can be harmful. Too much direction on the use of resources or models can lead to learners depending on them, and using them as "answer-getting devices rather than tools to explore a concept" (Van de Walle et al., 2010:29). Teachers do this in such a way that it may even look as if the learners understand, "but they could be just mindlessly following what they see" (Van de Walle et al., 2010:29). This suggests that there is a fine line between telling and guiding learners. Ma (2010:5) argues that children will not learn how to use resources on their own. Therefore, the direction that learners take with resources still depends largely on the teacher. The emphasis should be on concept development rather than process or rote memorisation (Abramovitz, 2012). Concept development will ensure understanding, the ability to apply knowledge and know when to use different resources in various situations.

## 2.4 HOW COULD MATHEMATICAL RESOURCES BE USED TO TEACH NUMBER CONCEPTS

Manipulatives can be helpful to young children when they are used correctly (Boggan et al., 2010:3). However, seeing the mathematical ideas in concrete materials is not always easy (Thompson, 1994:3). The material may be concrete, but the knowledge that learners need to acquire is conceptual. It is therefore important to know what materials to use, when to use them and how, in order to help children understand mathematical concepts being taught.

Counters, place-value mats, base-ten blocks, and fraction strips can be used to teach content area number 1 (numbers, operations and relationships). The counters can be used to teach one-on-one correspondence, ordinal numbers, and basic addition and subtraction. The fraction strips could be used to add and subtract fractions or to show equivalent fractions. It is also important for teachers to allow their learners to have free time to play with the manipulatives (Boggan et al., 2010:3)

Specific mathematical resources are designed to represent specific mathematical ideas that are abstract. They can be used as models by both teachers and learners; they hold a visual and tactile appeal, and, as such, are designed primarily for hands-on manipulation (Drews, 2007:21). Drews explains that the Dienes blocks and cuisenaire number rods (see figure 2.1) help learners recognise relationships within our base-10 number system and can be used to model the base-10 place-value system, like the relationship between one hundred and ten tens. This mathematical resource supports learners in making sense of decomposition, as an approach toward computations that involve the regrouping of numbers (Drews, 2007:22). Figure 2.1 shows mathematical resources recommended by the Curriculum Assessment Policy Statement (CAPS).

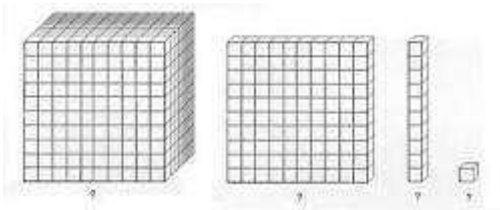
| | | |
|---|---|---|
| Counters |  | Counting, addition, subtraction, making groups, loose ones, help the learners represent addition, subtraction, division and multiplication situations. |
| Base-ten blocks (Diene's) |  | Develop the idea of a ten as a single entity. Reflects the relationships within our base-10 number system. Helps learners make sense of decomposition as a strategy for subtraction. |
| Cuisenaire rods |  | Basic operations and working with fractions and finding divisors. |

Figure 2.1 Mathematical resources recommended by Curriculum Assessment Policy Statement (CAPS)

The abacus and the bead string support learners in connecting counting to movement, and helps them to develop a sense of number order and number pattern (Drew, 2007:22). As learners progress, they need to progress to more abstract images like the number line, number track and flard cards. A number line can be useful in teaching learners to count forwards and backwards, and also to understand fractions (Drew, 2007:22). Figure 2.2 shows pictures of number charts, number tracks, flard cards, an abacus, a number line and bead strings.

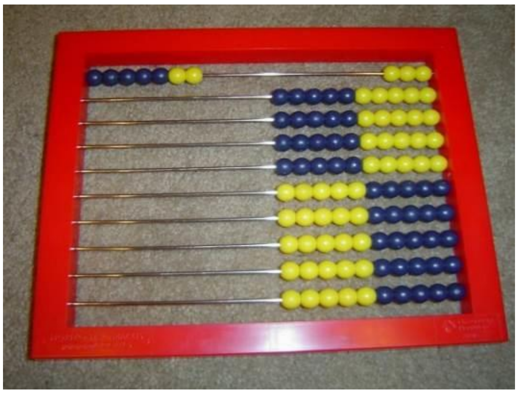
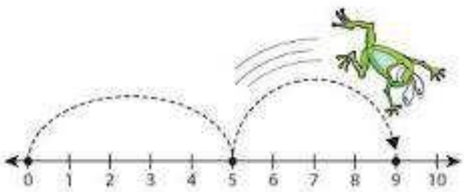
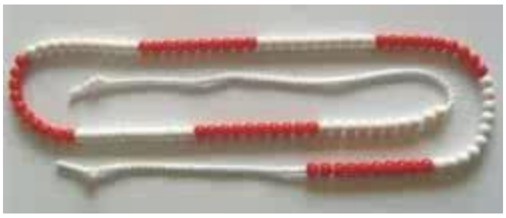
| | | |
|---|---|---|
| number charts |  | Counting, number recognition, number patterns. |
| number tracks |  | Counting on, back, shows the cardinal value of numbers. |
| Flard cards |  | To show how numbers are constructed. Hundreds, tens, and ones. Can work alongside the bundles. |
| Abacus |  | For grouping and showing loose ones. |
| Number line |  | Help calculate and allow learners a way to record their thinking and to keep track of it. Allows learners to have a recording image they can use to explain how they solved a problem. |
| bead strings |  | Counting, counting on. |

Figure 2.2 Mathematical resources recommended by Curriculum Assessment Policy Statement (CAPS)

Thompson warns against the mistake of thinking that a particular material or illustration, by itself, presents an idea unambiguously (Thompson, 1994:4). Teachers should be aware that representations may have more than one possible meaning for learners, and that learners may not always see what teachers want them to see in a representation. Learners should be given plenty of opportunity to explore various representations and to use materials for more than one concept, e.g. 2+1=3, 3-2 =1, 2 thirds, 2 out of 3. Thompson argues that it should be our goal to ensure that learners recognise and understand a variety of representations. Employing a variety of representations empowers learners to see different points of view and to choose the most appropriate representations or resources in a particular situation (Thompson, 1994:6). Basically, teachers ought to ensure that the appropriate materials are used at the right time, and understand that each step is crucial for understanding and should not be skipped.

## 2.5 HOW CHILDREN LEARN NUMBER CONCEPTS

The question of how children learn mathematics is one which many researchers have attempted to answer, but on which they have unfortunately never reached consensus (Rips, Bloomfield & Asmuth, 2008). It is important to understand the cognitive processes of learners in order to teach them effectively. In exploring this field I start by defining what is meant by number concepts.

### 2.5.1 What are number concepts?

According to Fayol and Seron (2005:3) number concept is the internal presentation of number "which corresponds to entities that are internal to the subject and refer both to systems of numerical notation and to the numerosity of sets of objects or real or mental events". Cayton (2008) agrees that this definition describes number concept best, as it acknowledges that all learners have a number concept irrespective of how advanced or complete it is. Rips et al. (2008) add that number concepts include, first, number as a cardinal value or "numerosity". This refers to the amount of objects in a set and answers 'how much' is there in a set? The second is "natural numbers" and arithmetic. These are all positive integers from 0 upwards, of which an important component is counting. Rips et al. (2008) discuss two types of counting: reciting the number sequence to a certain number, and advanced counting, which entails being able to get from any number to its successor, e.g. knowing that the next number after 28 is 29.

To venture a theory of how the above skills are attained, I refer again to Rips et al. (2008). Canvassing various theories of how children learn number concepts, they focus on the idea of innate natural number concepts. This entails magnitude and object individuation (the ability to single out objects), which implies that humans are born with some understanding of natural number.

### 2.5.2 Learning number concepts

Human beings depend on numbers for many activities. We use numbers to calculate equations, velocities, degrees and percentages. The number system permits people to measure, and symbolically represents boundless dimensions such as mass or distance, and a “universal system for using continuous mental magnitudes to represent number” (Brannon, 2006:222). Research conducted by Brannon (2006) shows that humans have a system for representing number that is independent of language and dates back to ancient times, before our system of counting and measuring was devised. Starr, Libertus and Brannon (2013) agree that young infants who are unable to speak and have no prior mathematical language have an intuitive sense of number. These “quantitative abilities” present in young children contribute to their success with number concepts at a later stage.

According to Rips et al. (2008), infants might start off with their own mental manner of representing cardinalities to understand number concepts. They may start with one idea demonstrating all sets with one component, a second demonstrating all sets with two components. They may use a simple pictorial mental system, with a symbol such as one dot representing all one item sets, 2 dots representing all two item sets and continuing with a new dot added to the previous ones to get to the following number symbol (Rips et al., 2008). This is difficult to study because it is an internal process of number which cannot be accessed directly by others (Cayton, 2008). In order for a child to have a broader understanding of number, he or she must first learn the cognitive model of the natural numbers (Cayton, 2008). A child must know that the term “one” represents the amount of objects in a set containing one item, the term “two” represents the amount of objects in a set representing two items, and so forth. One theory to explain how a child learns this concept is called inductive inference. This means that the child will eventually understand how the sequence of number works and see that the next number in the counting sequence grows by one every time.

There is much more to number concepts than inductive inference and the acquisition of cardinality. Number concepts cannot be discussed without discussing the external representations of number, as these are the results that help teachers make sense of learners’ internal concepts and processes (Cayton, 2008). These include both oral and written external representations. An external representation of a number is preceded by an internal search for a semiotic register, such as a numeral or number word. When humans are trying to express a thought, an unconscious process of choosing a sign, symbol or word occurs (i.e. identifying a semiotic register) that enables the thought to be presented externally so that it can be understood by others (Cayton, 2008). In order to understand the external representation, teachers must know what semiotic register was used by learners to create the external representation (Cayton, 2008).

Research conducted by Cayton (2008) shows that oral representation both reflects and affects the number concept of a learner. According to Brannon and Van de Walle (2001:55) the ability to count correctly allows a person to encode and compare amounts with greater accuracy. However, the fact that numerical systems differ from language to language may influence learners’ accuracy in counting and mathematical understanding (Marmasse, Bletas & Marti, 2000). Marmasse et al. (2000:2) assert that “the properties of such systems can facilitate or impede the development of learners’ mathematical understanding”. Linguistic aspects of numeration systems do not only “affect the speed of learning the counting sequence, but also influence learners’ understanding of place value”, which is associated with arithmetical computations (Marmasse et al. 2000:3). Marmasse et al. (2000) explain that Asian languages like Chinese are organised in such a way that numerical names are compatible with the traditional base-ten system. These countries also happen to be the best performing in mathematics (TIMSS, 2011). Spoken numbers correspond exactly with written equivalents: 15 is spoken “ten five” and 57 as “five ten seven”.

Brannon and Van de Walle (2001) maintain that oral representation is a powerful, accurate and widespread tool for working with numbers, and Cayton (2008) points that oral representation extends far beyond counting. Individuals who have mastered oral numbers do not need to count from one up to a particular number, in order to make sense of it. According to Marmasse et al. (2000), the basis for children’s arithmetical development is initially formed through simple counting using fingers or physical objects to avoid losing track of what has been counted already. Then, at a later stage, when a child has acquired linguistic competence, the ability to think with number words and verbal counting shapes children’s mathematical development. Marmasse et al. (2000) note that there are five principles that rule counting, as identified by Gelman and Gallistel (1978). The first three deal with “rules of procedure, or how to count, the fourth with the definition of countables or what to count and the fifth involves a combination of features of the other four principles” (Marmasse et al., 2000:3-4).

(i) The one-to-one principle

This principle stresses the significance of allocating only one counting label to each counted object in the collection. It emphasises saying the correct number name for each counted item in a group and only saying each number once when counting a group of objects. Children should not say “one”, and “one” again when counting the second object. They should know that after assigning “one” to an object, the next object will be “two”. In order to follow this principle, a child has to coordinate two processes, partitioning and tagging. This means that each counted item should not be counted again: counting continues for those that are not yet counted, while a specific name is used for each counted item and cannot be used again. There are many ways in which learners do this and keep track. One of the ways is pointing to the objects while saying the number name out loud (Marmasse et al., 2000:3-4)..

(ii) The stable-order principle

Allocating labels to objects in an array is not all that is required for counting. The counting labels must be arranged in a specific order. When counting three objects, a learner should start at one, then two, then lastly three (Marmasse et al., 2000:3-4).

(iii) The cardinal principle

This principle shows a learner's understanding that the last number said represents the amount of the whole set, the numerosity of the set (Marmasse et al., 2000:3-4).

(iv) The abstraction principle

The awareness of counted items is reflected in this principle. A learner should understand that counting can be applied to any set of objects. The objects do not have to be the same. They can differ in colour, shape and size (Marmasse et al., 2000:3-4).

(v) The order-irrelevance principle

A child has to learn that the order of enumeration (from left to write or right to left) is irrelevant. Consistent use of this principle does not seem to emerge until 4 or 5 years of age (German and Galistel, 1978). Children at the age of 3 may understand the basic principles of how to count but Piaget's experiments showed that counting proficiency and mature number sense only emerge at the age of 8. It seems that the innate, primitive mechanism of number understanding and counting needs constant refinement through practice and experience (Marmasse et al., 2000:3-4).

Counting is an important strategy for learners. It allows them to explore the relationships between numbers (Marmasse et al., 2000). It enables them to reflect on the order and position of numbers, and makes them aware that bigger numbers are made up of smaller ones. This helps them with problem-solving strategies. When learners become more proficient with counting numbers, they are given story sums to use whole numbers in meaningful situations (Safi, 2009). Safi's (2009) study shows that the path that learners follow to gain proficiency with number concepts.

Addition Strategy 1: Counting on

Foundation phase learners often use the counting on strategy when n addend is small. For example, to solve 8+4, learners will start with 8 and then count on 4 more (Safi, 2009).

Addition Strategy 2: Near doubling

Some learners solve 7+8 using a strategy called near doubling. Learners who use this stage recognise that 7+8 is close to double 7 and then just add 1 to get to the answer. This method uses a double plus 1 or double minus 1 approach (Safi, 2009).

Addition Strategy 3: Adding to ten

This strategy is used by learners when the sum of two numbers will be greater than ten. When learners solve 9+6, they make a full ten by looking at how much they need add to 9 to make it 10. Then they regroup the second addend, writing 9+6 as 9+1+5, solving the problem as 10+5 (Safi, 2009).

Subtraction Strategy 4: Using place value understanding to subtract by equal additions

Children who use this strategy have a good understanding of place value. They understand that 1 group of ten is equal to 10 loose ones and use the algorithm approach. Learners add the same amounts but add them in different place values. To solve the problem 62-27 using equal addition, the learners add 10 to both numbers (Safi, 2009).

The learners’ strategies illustrate their thinking process and approach to subtracting 7 from 2 in the number 62. Learners understand that by adding ten to 62, the same needs to be done to 27 to keep the difference the same and therefore not affect the answer (Safi, 2009) or add 8 to both numbers (62 – 27) → 70 – 35 = 35

Multiplication strategy 1: adding it up

Learners begin to understand multiplication when they have realised the conceptual meaning of the number of groups and the number of objects in each group (Safi, 2009). When solving the problem 6x7 learners who use this strategy would illustrate their mental process by writing: 7+7= 14, 14 + 7 = 21, 21+7 = 28, 28+7= 35, 35+7 = 42. Learners would use repeated addition to get to 6 x 7=42

Multiplication strategy 2: skip counting
Similarly to the previous strategy, learners keep a track of every time they count 7 by using their fingers or a technique for recording the number of groups counted. Learners using this strategy would count 7, 14, 21, 28, 35, 42. This approach presupposes knowledge of multiples of 7 (Safi, 2009).

Multiplication strategy 3: using known number facts
Learners may use what they already know to solve 6x7=. They know that 7+7=14, meaning there are 2 (7s) in the number 14, so 14+14 =28, 28 + 14 = 42. This strategy also resembles doubling strategies (Safi, 2009).

### 2.5.3 Magnitudes and object individuation

It is also suggested that there is a three-way distinction among infants' quantitative abilities (Rips et al., 2008:248). (a) with small sets of different objects, infants use discrete representations to discriminate the objects and maintain a trace of each; (b) with small sets of identical objects, infants depend on some continuous property from the representation (e.g. surface area) into a mental magnitude and then remember total magnitude; (c) with large sets of objects, infants form a magnitude for the total number.

It is believed that infants will be more successful with larger numbers using (c), as they are using a more reliable strategy which is the total number of items. Furthermore, people's ability to respond to the cardinality of large sets as well as small sets depends on individuating items in a set (Rips et al., 2008). The ability to represent a number of objects' cardinality is dependent on one's ability to individuate the objects. Rips et al.(2008) explain that this means being able to determine which elements in an array belong to the same object when dealing with a single or more objects. Rips et al. (2008) argue that this theory proves that children have a concept of number but not one of natural numbers. Children's concept of number does not qualify as true number representation and has to undergo conceptual change in order to qualify. The way to acquire natural number concepts is to transform a continuous representation into one that can be counted.

Rips et al. (2008) believe that children form a schema for numbers that specifies their structure as a countably infinite sequence. It is after this schema that they are able to use it to recognise and to extend fragmentary knowledge. The schema provides a representation for natural numbers through its elements. They believe that children do not learn natural numbers from knowledge of physical objects. Children's first exposure to arithmetic possibly comprises “object tracking, mental manipulation of images of objects, counting strategies, or mental look up of sums that do not require the numerals to refer to numbers” (Rips et al., 2008:256).

### 2.5.4 Understanding the commutative principle

Children understand the commutative property even before they are able to count the number of items in one or two groups. They have grasped the notion that for two separate groups of physical objects, A and B, certain spatial reorganisation does not change the amount or cardinality of their union (Rips et al., 2008). However, the commutative principle of addition refers to the fact that any two numbers, a and b, added together will produce the same result as b added to a. Children's discovery that the physical grouping of objects is commutative with respect to totals does not seem to transfer to the addition of numbers. It has been found that when children have learned addition, they do not automatically recognise the commutativity of specific totals (e.g., that $2 + 5 = 5 + 2$). Children would have to keep that knowledge and transfer the properties of addition and multiplication. They seem to discover the commutativity of addition only after noticing that these paired sums turn out to be the same over a range of problems.

Rips et al. (2008) argue that although learners do not see that addition is commutative, they use strategies that presuppose commutativity. They solve addition problems by counting all or counting on, starting from the bigger number and then adding the smaller one. Marmasse et al. (2000) refer to these as skilful strategies of counting. Learners would solve both 3+6 and 6+3 by starting at 6 and get the answer 9. However, they may not be able to affirm that 3 + 6 = 6+3 without performing the two addition operations separately and then comparing them. This tells us not to assume that learners' experiences have a direct influence on their understanding of mathematical properties. Also, their knowledge of objects will not be automatically transferred to that of numbers. If and when they are separately used, children will not make connections. Thus numbers and objects have to be used simultaneously until a certain level of understanding is reached. Gradually acquiring an understanding of the numerical system improves children's number sense. Number regrouping and decomposition accelerates problem solving and improves number understanding. After this, solving simple arithmetical problems involves direct memory retrieval of "hard wired facts" (Marmasse et al., 2000:6).

## 2.6 SUMMARY

This chapter has dealt with literature relevant to the research topic. It has provided a background for the study and discussed the poor performance of learners in mathematics. It has also furnished an overview of what other researchers have reported about mathematics resources in the foundation phase, including humans, materials, culture and time. The chapter went on to discuss the use of resources to teach number concepts and how they enhance learners' understanding of number concepts, also considering how children learn number concepts. The next chapter deals with the theoretical framework underpinning this study.

# CHAPTER 3
# THEORETICAL FRAMEWORK

## 3.1 INTRODUCTION

This chapter discusses the theoretical framework underpinning the study. “A research framework is central to every field of enquiry” (Lester, 2005: 458). It guides and conceptualises the research. A framework also helps the researcher to make sense of collected data. There are three kinds of framework that researchers use to support their investigations: practical, conceptual and theoretical (Lester, 2005). A theoretical framework guides research activities through reliance on a formal theory (Lester, 2005:458). It also provides an explanation for observed phenomena occurring within a domain covered by the theory (Niss, 2006:3). In the case of this research, the teaching and learning of mathematics in a classroom context comprise the observed phenomena to be explained. This chapter discusses Vygotsky’s (1978) sociocultural theory as a theoretical framework for this study of the use of resources and teaching mathematics to young children. A review of relevant prior studies will also be presented.

## 3.2 SOCIOCULTURAL THEORY

Vygotsky’s (1978) sociocultural theory underpins this study. Vygotsky’s work made a major contribution to the development of the social constructivist theory which guides the way in which teachers teach today and has helped shape the curriculum (Jaramillo, 1996:133). The researcher chose sociocultural theory, because of its relevance to the development of learners’ understanding in the teaching and learning of mathematics. Vygotsky taught and conducted research in a classroom setting which gave him valuable insights into how to connect educational research theory with practical application in the classroom (Jaramillo, 1996:133).

Vygotsky’s sociocultural theory is based on the idea that “knowledge represents a permanent construction, reconstruction and deconstruction of reality”, depending on the experiences of each individual (Alexandru, 2012:19). It regards knowledge not as a replacement of pre-existing structures but rather as the result of a build-up of prior knowledge. Thus, knowledge is a "subjective and individual process, which verifies cognitive, affective, behavioural schemes in relation to others, and also to the social environment" (Alexandru, 2012:19).

Vygotsky believed that the process of historical development is established in a systemic, dynamic emergence from the past, to the present and through the present into the future. He believed that there is no direct transition from one stage to another in historical development or from a lower psychological function to a higher one. It is rather a process of fundamental changes in quality and direction, thus arriving at a completely new plane. (Levykh, 2008:86)

According to John-Steiner & Mahn (1996:191) "Sociocultural theory is based on the concept that learning takes place in cultural contexts and is mediated by language and other symbol systems". This theory takes into account the important role that society plays in individual development and how learning is largely dependent on the social environment (Hall, 2007:94). It is a theory that considers "play and other informal activities as particularly important contexts in which adults provide children with new information, support their skill development, and extend their conceptual understanding" (Ramani & Siegler, 2014:2). Vygotsky emphasises experimental learning and advocates learning by doing (Jaramillo, 1996:137). He argues that meaning comes from experience and thus also emphasises the importance of problem solving in learning.

With different backgrounds preceding their schooling career, children come with a wide range of individual differences in their early number knowledge (Ramani & Siegler, 2014:2). Sociocultural theory claims that children's experiences in their early home environment and with informal number activities play a huge role in these differences and can influence children's mathematical development. Vygotsky (1978) believes that culture determines the way in which humans think. Van der Veer and van IJzendoorn (1985:3) agree that human beings construct their own environment which is responsible for their development. They explain that people from different cultural backgrounds develop differently in their higher psychological processes. It can thus be understood why learners from high or middle socio-economic backgrounds tend to perform better than those from low socio-economic backgrounds. Van der Veer and Van IJzendoorn (1985:3) indicate that the lower psychological processes of primitive and formally educated people are alike, but higher psychological processes like thought differ significantly between primitive and formally educated people. According to Vygotsky (1960), this is due to cultural causes.

The results of the South African National Study in mathematics and science (Reddy, 2004) support the above statements (Siyepu, 2013:1). These results reveal a difference in performance among provinces, with the Western Cape, Northern Cape and Gauteng being the three highest performers. The three lowest performers were KwaZulu Natal, Eastern Cape and Limpopo. The top provinces had almost twice the scores of the lowest performing province. Analysis of learners' performance revealed that learners in the former white schools have the highest scores whereas learners in African schools have the lowest scores. Learners in the former white schools have a score just below the international mean (Siyepu, 2013:1). The sociocultural perspective provides an impetus for examining how children's early home environment and interactions with adults can influence children's mathematical development. Crafter (2012:34) agrees that:

> "Specific cultural settings, like home and school, put constraints on the kinds of cultural models that parents are engaged with. For example, mathematical-based home activities such as counting the items on a shopping list with the help of a child, or using cooking to help with number, will only take place in some home settings and are linked to particular cultural models about home mathematics learning. These cultural models happen to be highly valued in the school setting. However, not all parents share the same resources with the school and therefore may not incorporate these kinds of practices into their cultural models."

The classroom environment should be carefully structured to enhance the higher psychological development of all learners. Teachers need to be aware that the way in which learners think is largely influenced by their culture, and this should inform their teaching approach. We cannot separate children's culture from their learning and thus our teaching. Individuals and their daily life environment are intertwined, so the focus should be on activity within socially assembled situations. Teachers should find ways to include learners' cultures, so that they can perform to their maximum ability, while at the same time making the necessary impact on their higher psychological development.

A sociocultural perspective emphasises the conversational and interactional aspects of human learning and understanding (Furberg & Arnseth, 2009:157). It foregrounds learners' meaning making processes in collaborative learning activities. To assist these processes, the use of resources is highly recommended by the Curriculum Assessment Policy Statement (CAPS, 2011). The use of resources is supported by both sociocultural learning theory as well as educational research in the classroom (Crafter, 2012:34).

## 3.3 MEDIATION VIA CULTURAL TOOLS IN THE TEACHING OF NUMBER CONCEPTS

Vygotsky (in Lantolf and Thorne, 2006:198-99) explains that human beings' minds have the capacity to go beyond their "lower-level neurobiological base" through the use of "higher-level cultural tools" to achieve higher level functions. Matusov and Hayes (2000:218) agree that higher level functions are founded in sociocultural development and involve the restructuring of lower level functions using cultural signs and tools endorsed by the society. As humans, we see the need and create ways to make our lives easier. Then we show and teach others through social interaction and by mediating the teaching process with cultural tools.

According to Crafter (2012:34) "Cultural models are understood to be shared, recognised and transmitted internal representations which link to external actions and representations". Through the use of cultural tools, human beings are able to achieve outcomes that are difficult to achieve and elevate the person above the environment. We use ladders to reach things that are too high for us and hose-pipes to fill pools with water instead of a whole lot of buckets. Sociocultural theory advocates that:

> A human child is naturally gifted with a wide range of perceptual, attention and memory capacities such as the capacity to perceive contrast and movement, eidetic memory and habitual responses to environmental stimuli. Such basic processes also referred to as biological or natural by Vygotsky can be transformed to higher psychological functions or the unique forms of cognition through socialising, education and language (Moll, 1990:127)

The relationship between human beings and the physical world is mediated by concrete materials or tools (Lantolf & Thorne, 2006:198-99). Vygotsky (1978) points out that the transformation of lower level psychological functions into higher level psychological functions can be specific for each function and depends on both the biological and the sociocultural development of the child. Matusov and Hayes (2000:218) note that in some traditional societies certain functions remain at lower, biological level even in adulthood. Every neo-formation is the outcome of a personality battle with the different and rising demands of a certain environment during a period of crisis, and it results in the derivation of the new psychological structure; it is a process of rebuilding the personality that assumes a dialectical understanding of development (Levykh, 2008:86).

Neo-formation refers to the formation of a new mental system that is able to educate or guide other mental systems in order to further cultural development (Levykh, 2008:86). Vygotsky viewed a higher mental function as a uniquely cultural form of adaptation which involves a connection with basic psychological functions as well as the reorganisation thereof (Levykh, 2008:86). Vygotsky maintains that such reorganisation is only possible through the use of cultural tools.

## 3.4 LANGUAGE AS A SOCIAL AND PSYCHOLOGICAL TOOL

Vygotsky's sociocultural theory emphasises the importance of language and states that "language is a cultural signal and tool that communicates speech. Language provides a framework for using external speech and internal speech to make meaning of situations. Making the learner's internal speech external will help the learner to come up with mathematical solutions" (in Hines, 2008:4).

Vygotsky also believed that in order for learning to take place, word meaning is important. Language should serve as a mediating tool between the learner and what needs to be learnt as “meaning cannot be separated from words and words without meaning is an empty sound and no longer part of human speech” (Vygotsky, 1986:5-6). It is therefore crucial for Foundation Phase teachers to understand that, as important as language is, words can be without meaning for young learners. Language alone is not always sufficient mediation for young learners; it has to work in collaboration with other mediation tools. Thus Vygotsky puts emphasis on mediation through the use of cultural tools – such as interaction with other people and concrete materials – and not just the particular tool of language (Lantolf & Thorne, 2006:198-99). While language is important, much more needs to be put in place for learners to make sense of number concepts. Learners need to make personal meaning of mathematical concepts such as addition, subtraction, multiplication, division, money; place value; describing, ordering and comparing numbers (Vygotsky in Hines, 2008:2).

Berk and Winsler (1995:17) argue that in order for children to master conversation and other concepts, they have to take part in everyday activities that promote a certain way of thinking. They need to be given numerous opportunities to practically add, subtract, share equally. These opportunities do not have to end in the classroom: teachers can give learners homework which will help reinforce lessons that were taught and thus extend their learning (Bornman & Rose, 2010:87). Jabagchourian (2008:30) points out that a lot of effort involving new mental routes is exerted by learners when they are finding and implementing a strategy to follow a procedure. He explains that practice makes procedure become easier to perform as it becomes automatised. It is after the automisation of procedures that the cognitive capacity will be freed up. This allows for extra cognitive capacity. Young learners’ meta-cognitive processes can check their procedures and look for alternative clues in the problem and in their knowledge to create potential connections. Learners are then able to solve similar problems through metacognitive processes that modify the objective sketch to enable the discovery of a new strategy rather than the previous dominant strategy used (Jabagchourian, 2008:30).

Diaz and Berk (2014:5) agree that young children do not only use language for social communication and interaction, but also to guide, plan and monitor their own activity in a self-regulatory manner. Language is an important mediator, because it mediates not only social interaction between people but also cognitive activity within individuals. Diaz and Berk (2014:5) explain that children use language as a tool to think (also referred to as private or inner speech ) and thus create a major link between social and cognitive occurrences. Vygotsky explains that private speech enables children to plan their activities and strategies and is therefore a crucial component in cognitive development (McLeod, 2013).

## 3.5 THE ZONE OF PROXIMAL DEVELOPMENT IN TEACHING NUMBER CONCEPTS

The zone of proximal development (ZPD) is one of Vygotsky's (1978) sociocultural tenets (Wright, Martland, Stafford & Stanger, 2006:28). Vygotsky defines the ZPD as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or collaboration with the more capable peers" (Vygotsky, 1978:86). The ZPD relates to knowledge that the learner is capable of learning with appropriate teaching, support and guidance by the more knowledgeable other (Wright et al., 2006:28). This guidance is also referred to as "other regulation" and includes both "implicit and explicit" mediation involving varying levels of assistance (Lantolf & Thorne, 2006:200).

As mentioned before, Vygotsky (1978) believes that interaction with other people and people who know more (more knowledgeable others) will mediate between the learner and what the learner needs to learn (De Guerrero & Villamil, 2002:51-52). The more knowledgeable other should provide opportunities for learners to learn mathematics by providing the necessary support and tools and using the ZPD to scaffold the process of learning (Vygotsky, 1978).

The ZPD can be divided into 4 stages (Dunphy & Dunphy, 2003: 49-50). These stages attempt to explain what happens at the beginning of teaching a concept, during the teaching and after the teaching.

- Stage 1 is where learning is assisted by the more knowledgeable other (Dunphy and Dunphy, 2003: 40-50). This is the stage where the teaching of concepts starts and where the learners have little understanding thereof. It is during this stage that teaching and intervention occurs in different ways, including modeling, coaching and other methods of scaffolding (Polly, 2012:81).

- Stage 2 is called self-assisted. This is when the learner is able to perform and carry out tasks independently and is trying to make sense of tasks independently. This does not mean that the performance is fully developed or internalised. It merely means that the control and direction of the performance has been passed on to the learners (from other-regulation to self-regulation).

- Stage 3 is where performance is developed and automatised. At this stage the learner is fully able to perform on his/her own and has advanced from the ZPD into the developmental stage for the task. The task is now achievable without intervention or assistance from the more knowledgeable other.

- Stage 4 is where de-automatisation of performance leads to going back through the ZPD and starting from stage 1 again. Dunphy and Dunphy (2003:49-50) observe that “for every individual, at any point in time, there will be a mix of other-regulation, self-regulation, automised and deautomatised processes”. Teachers should also understand that learners will not necessarily move through these stages the same way or at the same time. It is the teacher’s responsibility to assist the learner’s performance through the zone into the next phase (Vygotsky, 1978).

Through their research aimed at improving the mathematics results of some schools, Scott and Graven (2013:7) realised that the ZPD is not a ‘physical space’ in the learners' prior learning activities. They had thought that the ZPD theory was a way of recognising where the learners were in terms of their existing understanding in order to plan activities and ways to mediate the learning processes. They came to realise through their study and interaction with learners that the ZPD was rather more "fluid than a fixed set of predetermined possibilities" (Scott & Graven, 2013:7). They found that the ZPD was largely influenced by the learners' interaction with the activity, which was also dependent on social, emotional, health and other interactional influences. Furberg and Arnseth (2009:158) agree that "focusing on the learners' actual interaction during collaborative learning activities enables teachers to describe how learners' meaning making of conceptual representations emerges in a particular setting and is responsive to the characteristics of the setting".

This means that learners' performance could vary from activity to activity, day to day, and under different contexts, depending on the above-mentioned interactional influences. Children move through the ZPD in ways which are predictable, as a result of making their own sense of what is provided by the teacher. Bliss, Askew and Macrae (1996:39) add that "in the school context, the ZPD is not characterised by an invariant task because the negotiation between teacher and child may change it". Scott and Graven (2013:7) only came to realise the above through reflection. It was through reflecting on each learner's progress and proficiency that these researchers were able to come to appreciate the emergence of each learner's ZPD (Scott & Graven, 2013:6). This is important in teaching, as teachers need constantly to reflect on teaching and learning so as to recognise their learners' ZPD and the direction to follow next.

### 3.5.1 Scaffolding in the teaching of number concepts

The concept of scaffolding is also used in sociocultural theory and is based on the idea "that a task beyond the learner's ZPD can become accessible if it is carefully structured" (Van de Walle et al., 2010). For concepts completely new to learners, learning requires more structure or assistance, including the use of tools such as language, manipulatives or the assistance of peers. Scaffolding does not merely mean simplifying the task while the learners are learning. It rather means holding the task constant while simplifying the learner's role through the graduated intervention of the teacher (Greenfield, 1984:119). The notion of the ZPD is explained by Wertsch (1985;60-61):"Any function in the student's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an inter-psychological category and then within the student as an intra-psychological category".

## 3.6 INTERNALISATION

Sociocultural theory maintains that knowledge is first acquired interpersonally, then intrapersonally, as learners first learn from others, then internalise or individualise knowledge to best suit their needs (John-Steiner & Mahn, 1996:191). Vygotsky claims that children learn from outside in. He argues that: "What goes from outside the learner, then inside the learner is schooling because we would never find children who would naturally develop arithmetic functions in nature. These are external changes coming from the environment and are not in any way a process of internal development" (DeVries, 2000:12).

Teachers are placed in a crucial and important position of ensuring that the social environment is well structured and organised to enhance learning and to bridge the gap that might have been caused by the learners' home environment and background like insufficient informal exposure to number concepts. Bracken and Crawford (2009:421) agree that "children must possess the foundational language and knowledge necessary to explore, comprehend, and discuss topical concepts in all content areas if they are to succeed academically".
Vygotsky's (1978) sociocultural theory states that it is not possible for children to learn in isolation or on their own (Hall, 2007:96). Learning is a social and cultural act rather than an individual phenomenon (Vygotsky, 1978). Cognitive development occurs as a result of other people interacting with the learner while using tools to mediate and facilitate the learning process (Hall, 2007:96). These mediation tools can also be referred to as cognitive tools. Cognitive tools or mind tools are arithmetically centred tools that meet and extend the mind (Jonassen, 1981:1). Cognitive tools have the ability to promote higher order thinking and learning when

used well. As Wertsch (1990:114) puts it, “The fundamental claim is that human activity (on both the inter-psychological and the intra-psychological plane) can be understood only if we take into consideration the ‘technical tools’ and the ‘psychological tools’ or signs that mediate the activity”.

Technical tools can be defined as physical resources used in learning and can range from textbooks, teaching notes, and calculators to classroom written activities, while psychological tools include language, counting systems, mnemonic techniques, art, writing, diagrams and maps (Siyepu, 2013:7). It is also important to note that learners are not expected to depend on the tools forever.

Vygotsky (1978) believes that children are not blank slates, they always already have some knowledge and background. Therefore, when learners are provided with the right support and resources they can and will reach their maximum potential. He defined learning as “the use of social and cultural order to grasp the meaning of information”, suggesting that learning is almost impossible without language and interaction with other people. To prove the importance of the above assertion, Lephalala and Makoe (2012:2-3) highlight the high failure rate of students graduating at universities that use distance learning. They believe that one of the reasons that the majority of students, especially those from disadvantaged backgrounds have not been successful in completing their studies through distance learning is because of the lack of interaction between lecturers and students. Individual cognition happens in a social situation (Jaramillo, 1996: 135). Lephalala and Makoe (2012) agree that learning is not a “monologue” but rather a “dialogue”. The tendency for lecturers to only send out study material to the students, with the assumption being that students do not necessarily require mediation or support as they go through their study material, is a major challenge faced by students (Lephalala & Makoe, 2012:2-3).

The growing prevalence of diversity in our society suggests that we change from denouncing diversity as a weakness to embracing it as a strength (Sleeter & McLaren, 1995:1). Many teachers are aware of this change and “generally agree that effective teaching requires mastery of content knowledge and pedagogical skills” (Gay, 2002:106). This includes knowledge of the learner population as well as the subject matter. However, a lot of teachers are not equipped and sufficiently prepared to teach culturally diverse learners (Gay, 2002:106). Teachers should focus on the individuals and understand the complex of social, historical, economic and cultural relations that influence learning and the quality of life. It is necessary to determine what social environments and relations can be designed to better fulfil the learners' needs or as Sleeter and McLaren (1995:1) state, "if we do not promote an understanding of difference in historical, racial, and gendered specifity, educational progress will be hindered".

## 3.7 CRITIQUE OF SOCIOCULTURAL THEORY

Some aspects of Vygotsky's sociocultural theory have attracted criticism. His distinction between higher and lower psychological processes has been criticised by van der Veer and van IJzendoorn for being too sharp (1985:1). They note that Vygotsky identifies higher order processes as "logical memory, creative imagination, verbal thinking and regulation of actions by will", and lower processes as direct perception which is "natural and passive". The higher psychological processes are mediated by signs and are socially formed, while the lower psychological processes are biological. The Kharkov school of development disagrees. They argue that the lower psychological processes are indeed active, maintaining that all psychological processes are a result of external actions (van der Veer and van IJzendoorn,1985:1).

According to van der Veer and van IJzendoorn (1985:1) Vygotsky implies that the influence of culture on the cognitive development of the child is solely the result of social interaction. Soviet researchers contest this theory by pointing out that the child is also actively interacting with objects and surroundings influenced by culture. Through this interaction the child acquires knowledge about his or her environment, and this interaction influences the development of the psychological processes that Vygotsky considered "natural". What is more, Vygotsky restricted the influence of social interaction to speech, thus dismissing developmental phases lacking language as "natural" (van der Veer and van IJzendoorn, 1985:7).

Vygotsky also held that higher psychological processes could be studied experimentally (van der Veer and van IJzendoorn,1985:1), a view opposed by Wundt (in van der Veer and van IJzendoorn, 1985:2). Wundt argues that it is impossible to study higher processes like thought, learning, memory, volition etc. experimentally. He states that they can only be studied indirectly. In order to truly understand how higher psychological processes develop, we must consider the evolutionary development and diversification of human beings in terms of language, morals, religion etc. (van der Veer and van IJzendoorn, 1985:2).

Vygotsky's notion of the Zone of Proximal Development is also criticised for not being specific enough in stating how one intervenes in the Zone of Proximal Development. Vygotskian teachers differ widely in the teaching they present as models for this purpose (DeVries, 2000:15). When compared to Piaget, education based on Vygotsky's theory is less detailed, and "[m]ore consensus exists among Piagetian constructivist educators than among Vygotskian educators" (DeVries, 2000:15).

This being said, it is also important that we understand that there is no "well established unified theory of mathematics" in education (Niss, 2006:5). Different theories have been used in mathematics and they have all been criticised (Niss 2006:8). This is not to say they are all bad, but as I have already said, there is no single perfect one that has remained unchallenged.

## 3.8 SUMMARY

It is important to note the contribution made by sociocultural theory to the way in which we teach today. Sociocultural theory attempts to explain the way in which children learn and the direction to be taken in attempting to help them do so. Different steps have been discussed including those associated with the ZPD. Moving learners from the known to the unknown using cultural tools and teaching within the ZPD have been the highlights of this theoretical framework. This is the job of all teachers, to teach learners effectively in moving them from the known to the unknown at the correct pace and using the correct tools.

The next chapter features a detailed discussion of the design and methodology of this research. It provides a rationale for using a case study approach within the interpretive qualitative research paradigm. Various aspects of the case study are discussed in detail, including the context, the research site, sampling and data collection.

# CHAPTER 4
# RESEARCH DESIGN AND METHODOLOGY

## 4.1 INTRODUCTION

The previous chapter explored Vygotsky's sociocultural theory, the theoretical framework underpinning this study. This chapter deals with the research design and methodology of the study. It discusses qualitative research, and the case study and data collection processes. In data collection the focus is on the site, the sampling of participants and research instruments. The research instruments employed to find out how teachers used resources to teach number concepts in this study were document analysis, observation and semi-structured interviews. This chapter discusses data analysis, trustworthiness, triangulation, credibility, transferability, confirmability and ethical considerations.

## 4.2 QUALITATIVE RESEARCH

This research is qualitative by nature, and located within the interpretive qualitative research paradigm, using a case study approach. Interpretive research seeks to understand phenomena through the meanings that people bring to them. It "aims at producing an understanding of the context of the information system" (Goldkuhl, 2012:4-5). Interpretative qualitative research focuses on the full complexity of human sense making in a given situation:

> Interpretive methodologies position the meaning making of human actors at the centre of scientific explanation. Interpretive research focuses on analytically disclosing those meaning making practices, while showing how those practices configure to generate observable outcomes (Institute of Public & International Affairs, 2009:1)

Qualitative research entails a set of methods that depend on data collected through language, that is, it relies on linguistic rather than numeric data (Elliott & Timulak, 2005:147). Qualitative research seeks to acquire a thorough understanding of a specific field of study and is aimed at uncovering a specific population's behaviour and the perceptions that underpin it in relation to specific topics or issues (Cooper, Flescher & Cotton, 2012; QRCA, 2013). It involves a detailed study of groups of people to guide and support the creation of hypotheses (Frederick, 2013). The results of qualitative research are descriptive rather than predictive (QRCA, 2003:1), involving explanations and referring to people's actions, verbalised thoughts and observed behaviour. An important aspect of a qualitative study is that it generally depends on inductive reasoning processes to interpret and structure the meanings that can be derived from data. Inductive reasoning is the process whereby the researcher uses collected data to generate ideas (hypothesis generating), whereas deductive reasoning begins with the idea and uses the data to "confirm or negate" the idea (hypothesis testing) (Thorne, 2000:68).

**Characteristics of qualitative research**

Qualitative research attempts to find out how people feel about their circumstances, the situations that they find themselves in (Thorne, 2000:68). Qualitative research is a form of research in which the researcher goes to people and the site to collect data (Strauss and Corbin, 2015). This enabled the researcher to observe teaching in a natural setting. Also, in qualitative research, the researcher interprets collected data. This makes the researcher part of the research process, along with the participants and the data they provide (Strauss and Corbin, 2015). Cresswell (2007) sums up these characteristics of qualitative research:

- Is often conducted in the field, allowing direct interaction with the people being studied in their context.
- Researchers collect data themselves by examining documents, observing behaviour or interviewing participants.
- Multiple sources of data are preferred over a single source; this requires the researcher to review all data, make sense of it and organize it into categories or themes that cut across all sources.
- Researchers often build their patterns, categories and themes from the bottom up (inductive analysis).

## 4.3 CASE STUDY

This research was a small-scale project that used a case study approach, one of several approaches that can be used in small-scale research, such as action research, comparative research, evaluation and experiment research (Thomas, 2011:3). According to Yin (2009) a case study has a twofold technical definition. The first part concerns the scope of a case study is an empirical inquiry that

- Investigates an existing phenomenon in depth and within its real-life context, especially when the
- boundaries between phenomenon and context are not clearly evident (Yin, 2009:18).

Yin (2009) argues that “this first part of technical definition suggests that the case study method is used to understand a real-life phenomenon in depth, but that such understanding encompasses important contextual conditions” (Yin, 2009:18). The second part of Yin’s technical definition of a case study is as follows:

The case study inquiry copes with a technically distinctive situation in which there will be many more variables of interest than data points, as one result:

- relies on multiple sources of evidence, with data needing to converge in a triangulation fashion, and as another result,
- benefits from the prior development of theoretical prepositions to guide data collection and analysis (Yin, 2009:18).

Yin (2009:18) claims that “in essence, a twofold definition shows how case study research comprises an all-encompassing method covering the logic of design, data collection techniques, and specific approaches to data analysis”.

## 4.4 DATA COLLECTION

### 4.4.1 Site

This research was conducted in two primary schools. One of the schools is where the researcher was teaching at the time of the study, and this is referred to as School A. The second school is a nearby school which is referred to as School B. School A is in the sub-area of Athlone in the Western Cape. The school is in a previously Afrikaans-speaking community with a low socioeconomic status. At the time of the study there were 542 learners enrolled at the school, from the area and surrounding areas. There were 16 teachers at the school and two classes in each grade. There were 8 Foundation Phase teachers from Grade R to Grade 3. The following table shows the number of learners in the Foundation Phase, excluding Grade R as they were not part of the study.

Table 4.1 Number of learners from Grade 1 to Grade 3 in school A

| Grade | Class | Number of learners |
|---|---|---|
| 1 | A | 38 |
| 1 | B | 38 |
| 2 | A | 39 |
| 2 | B | 39 |
| 3 | A | 39 |
| 3 | B | 40 |

School B is in a sub-area also in Athlone. The school had 503 learners from surrounding areas with low socio-economic status as well. The school is a previously dual-medium Catholic school.

Table 4.2 number of classes and learners in school B

| Grade | Number of classes | Number of learners |
|---|---|---|
| Grade 1 | 3 | 31 |
| Grade 2 | 2 | 43 |
| Grade 3 | 2 | 43 |

School A and B’s Foundation Phase classrooms both have large mats in front on which to teach mathematics in small groups. School A is fairly equipped with mathematics resources and has a mathematics resource box with all the resources recommended in the CAPS document – the Learner and Teacher Support Material (LTSM) kit. Teachers from Grade 1 to 7 are all entitled to borrow from this box and return the resources after use. At school B however, each Foundation Phase class has its own LTSM kit.

### 4.4.2 Sampling of participants

The researcher’s sample is purposive. The participants were selected on the basis of knowledge of a population and the purpose of the study (Orb, Eisenhauer & Wynaden, 2000:93). The teachers selected were all Foundation Phase teachers with experience of teaching in the phase and they all had mathematical resources in their classes. The researcher worked with 5 Foundation Phase teachers, two of whom were from the school at which the researcher was teaching at the time of the study (school A), while three were from school B.

The researcher worked with teachers from Grade 1 to Grade 3 mainly, because the researcher felt that it was in Grade 1 that mathematics was formally introduced to learners. Grade 2 was a progression from Grade 1 and Grade 3 was the learners’ last grade in the Foundation phase. Grade 3 was also where the performance of the whole phase was tested through systemic assessment. The researcher decided to work with one teacher per Grade in each school. The teachers were selected according to their experience in the Grade concerned. The researcher chose to work with teachers with the most experience in school A. In school B the Foundation Phase Head of Department (HoD) was requested to identify three of her most experienced teachers. The researcher’s interest was in ascertaining how Foundation Phase teachers use mathematical resources to teach number concepts. The following table contains relevant information (biographical data) pertaining to the participants.

Table 4.2 Information about participants

| Teacher | Age | Number of years teaching mathematics in the Foundation Phase | Qualification | Total number of years teaching. |
|---|---|---|---|---|
| Teacher 1A | 28 | 3 | BEd (Foundation Phase | 4 |
| Teacher 2A | 57 | 35 | HDE | 35 |
| Teacher 1B | 28 | 5 | BEd (Foundation Phase | 5 |
| Teacher 2B | 35 | 5 | HND (senior phase in Zimbabwe)<br>ACE ( FP) | 13 |
| Teacher 3B | 40 | 5 | BEd (Foundation Phase | 5 |

There was a great range in age, experience and qualifications among the teachers. This made the researcher aware from the start that there could be vast differences in the way in which resources were used in these teacher's classes.

### 4.4.3 Research Instruments

Research instruments are the tools we use to collect data (Annum, 2015). These include document analysis, non-participatory observations and semi-structured interviews. It is important for the researcher to ensure that the research instruments used are valid and reliable. The validity and reliability of a research study depends on the suitability of the instruments used to answer the research question (Annum, 2015). The instruments that suited this study best were document analysis, non-participatory observation and semi-structured interviews. The following sections discusses and explains these instruments.

#### 4.4.3.1 Document analysis

Document analysis is a "form of qualitative research in which documents are interpreted by the researcher to give voice and meaning around an assessment topic where data is processed through systematisation, categorisation and interpretation" (Yu, Jannasch-Penell & Digangi, 2011:738). A document a paper or text which relates to some aspect of the social world. Official documents are intended to be read as objective statements of fact but they are themselves socially produced (Yu, Jannasch-Penell & Digangi, 2011:738).

Document analysis in this research referred to teachers' lesson plans. A copy of each teacher's lesson plans was obtained and analysed. The plans were evaluated to see how and how far they allowed for the inclusion and use of mathematical resources. This helped the researcher to see what was supposed to be happening in the lessons, as well as to establish the teachers' expectations of learning activities.

The use of lesson plans as data can be advantageous because the data is permanent: it can be checked in its original form by others and enables enquiry into past lessons. A disadvantage is that the lesson plans may be incomplete (Burton, Brundrett & Jones, 2011: 123). Below (see table 4.3) is an overview of what should be taught and known at the end of the year in each of the Foundation Phase grades according to CAPS.

Table 4.3 CAPS Foundation Phase Numbers operations and relationships overview

| MATHEMATICS PHASE OVERVIEW | | | | |
|---|---|---|---|---|
| **1. NUMBERS, OPERATIONS AND RELATIONSHIPS** | | | | |
| **Progression in Numbers, Operations and Relationships**<br>• The main progression in Numbers, Operations and Relationships happens in three ways:<br>o The number range increases.<br>o Different kinds of numbers are introduced.<br>o The calculation strategies change.<br>• As the number range for doing calculations increases up to Grade 3, learners should develop more efficient strategies for calculations.<br>• Contextual problems should take account of the number range for the grade as well as the calculation competencies of learners. . | | | | |
| **TOPICS** | **GRADE R** | **GRADE 1** | **GRADE 2** | **GRADE 3** |
| **NUMBER CONCEPT DEVELOPMENT: Count with whole numbers** | | | | |
| **1.1**<br>**Count objects** | **Count concrete objects**<br>Estimate and count to at least 10 everyday objects reliably. | **Count concrete objects**<br>Estimate and count to at least 50 everyday objects reliably. Counting by grouping is encouraged. | **Count concrete objects**<br>Estimate and count to at least 200 everyday objects reliably. Counting by grouping is encouraged. | **Count concrete objects**<br>Estimate and count to at least 1 000 everyday objects reliably. Counting by grouping is encouraged. |
| **1.2**<br>**Count forwards and backwards** | Count forwards and backwards in ones from 1 to 10;<br>Use number rhymes and songs | Count forwards and backwards in ones from any number between 0 and 100.<br><br>**Count forwards in:**<br> 10s from any multiple of 10 between 0 and 100<br> 5s from any multiple of 5 between 0 and 100<br> 2s from any multiple of 2 between 0 and 100 | Count forwards and backwards in:<br> 1s from any number between 0 and 200<br> 10s from any multiple of 10 between 0 and 200<br> 5s from any multiple of 5 between 0 and 200<br> 2s from any multiple of 2 between 0 and 200<br> 3s from any multiple of 3 between 0 and 200<br> 4s from any multiple of 4 between 0 and 200 | Counts forwards and backwards in:<br> 1s from any number between 0 and 1000<br> 10s from any multiple of 10 between 0 and 1000<br> 5s from any multiple of 5 between 0 and 1000<br> 2s from any multiple of 2 between 0 and 1000<br> 3s from any multiple of 3 between 0 and 1000<br> 4s from any multiple of 4 between 0 and 1000<br> in 20s, 25s, 50s, 100s to at least 1000 |
| **NUMBER CONCEPT DEVELOPMENT: Represent whole numbers** | | | | |
| | Say and use number names in familiar context. | | | |
| **1.3**<br>**Number symbols and number names** | **Recognise, identify**<br>**and read numbers**<br> Recognise, identify and read number symbols 1 to 10 | **Recognise, identify and read number**<br>**symbols**<br> Recognise, identify and read number symbols 1 to 100<br> Write number | **Recognise, identify and**<br>**read number**<br> Recognise, identify and read number symbols 0 to 200 | **Recognise, identify and**<br>**read number**<br> Recognise, identify and read number symbols 0 to 1 000<br> Write number |

| | | | | |
|---|---|---|---|---|
| | □ Recognise, identify and read number names 1to 10 | symbols 1 to 20<br>□ Recognise, identify and read number names 1 to 10<br>□ Write number names 1 to 10 | □ Write number symbols 0 to 200<br>□ Recognise, identify and read number names 0 to 100<br>□ Write number names 0to 100 | symbols 0 to 1000<br>□ Recognise, identify and read number names 0 to 1 000.<br>□ Write number names 0 to 1 000 |
| **NUMBER CONCEPT DEVELOPMENT: Describe, compare and order whole numbers** | | | | |
| **1.4**<br>**Describe, compare and order numbers** | **Describe, compare and order collection of objects up to 10.**<br>□ Describe whole numbers up to 10<br>□ Compare which of two given collection of objects is big, small, smaller than, greater than, more than, less than, equal to, most, least, fewer up 10.<br>Order more than two given collections of objects from smallest to greatest up to 10<br>**Use ordinal numbers to show order, place or position**<br>Develop an awareness of ordinal numbers e.g. first, second, third up to sixth and last<br>**Use ordinal numbers to show order, place or position**<br>□ Develop an awareness of ordinal numbers e.g. first, second, third up to sixth and last | **Describe, compare and order objects up to 20**<br>□ Describe and compare collections of objects according to most, least, the same as<br>□ Describe and order collections of objects from most to least and least to most<br>**Describe, compare and order numbers to 20**<br>□ Describe and compare whole numbers according to smaller than, greater than and more than, less than, is equal to<br>□ Describe and order numbers from smallest to greatest and greatest to smallest<br>**Use ordinal numbers to show order, place or position**<br>□ Position objects in a line from first to tenth or first to last e.g. first, second, third … tenth | **Describe, compare and order numbers to 99**<br>□ Describe and compare whole numbers up to 99 using smaller than, greater than, more than, less than and equal to<br>□ Describe and order whole numbers up to 99 from smallest to greatest, and greatest to smallest<br>**Use ordinal numbers to show order, place or position**<br>□ Position objects in a line from first to twentieth or first to last e.g. first, second, third … twentieth | **Describe, compare and order numbers to 999**<br>□ Describe and compare whole numbers up to 999 using smaller than, greater than, more than, less than and equal to<br>□ Describe and order whole numbers up to 999 from smallest to greatest, and greatest to smallest<br>**Use ordinal numbers to show order, place or position**<br>□ Use, read and write ordinal numbers, including abbreviated form (1st, 2nd, 3rd up to 31 |

| NUMBER CONCEPT DEVELOPMENT: Place value | | | | |
|---|---|---|---|---|
| **1.5**<br>**Place value** | | **Begin to recognise the place value of at least two-digit numbers to 20**<br> Decompose two-digit numbers into multiples of 10 and ones/units | **Recognise the place value of at least two-digit numbers to 99**<br> Decompose two-digit numbers up to 99 into multiples of 10 and ones/units<br>Identify and state the value of each digit | **Recognise the place value of three-digit numbers to 999**<br> Decompose three-digit numbers up to 999 into multiples of 100, multiples of 10 and ones/units<br>Identify and state the value of each digit |
| **SOLVE PROBLEMS IN CONTEXT** | | | | |
| **1.6**<br>**Problem solving techniques** | Use the following techniques up to 10:<br> concrete apparatus e.g. counters<br> physical number ladder | Use the following techniques when solving<br>problems and explain solutions to problems:<br> concrete apparatus e.g. counters<br> pictures to draw the story sum<br> building up and breaking down numbers<br> doubling and halving<br> number lines supported by concrete apparatus | Use the following techniques when solving problems and explain solutions to problems:<br> drawings or concrete apparatus e.g. counters<br> building up and breaking down of numbers<br> doubling and halving<br> number lines | Use the following techniques when solving problems and explain solutions to problems:<br> building up and breaking down numbers<br> doubling and halving<br> number lines<br> rounding off in tens |
| **1.7**<br>**Addition and subtraction** | Solve word problems (story sums) in context and explain own solution to problems involving addition and subtraction with answers up to 10. | Solve word problems in context and explain own solution to problems involving addition and subtraction with answers up to 20. | Solve word problems in context and explain own solution to problems involving addition and subtraction with answers up to 99. | Solve word problems in context and explain own solution to problems involving addition and subtraction leading answers up to 999. |
| **1.8**<br>**Repeated addition leading to multiplication** | | Solve word problems in context and explain own solution to problems involving repeated addition with answers up to 20. | Solve word problems in context and explain own solution to problems using repeated addition and multiplication with answers up to 50. | Solve word problems in context and explain own solution to problems using multiplication with answers up to 100. |
| **1.9 Grouping and sharing lead into division** | Solve and explain solutions to word problems in context (story sums) that involve equal sharing, grouping with whole numbers up to 10 and answers that may include remainders. | Solve and explain solutions to practical problems involving equal sharing and grouping with whole numbers up to 20 and with answers that may include remainders. | Solves and explain solutions to practical problems that involve equal sharing and grouping up to 50 with answers that may include remainders. | Solve and explain solutions to practical problems that involve equal sharing and grouping up to 100 with answers that may include remainders |

| | | | | |
|---|---|---|---|---|
| **1.10**<br>**Sharing leading to fractions** | | | Solve and explain solutions to practical problems that involve equal sharing leading to solutions that include unitary fractions. | Solve and explain solutions to practical problems that involve equal sharing leading to solutions that include unitary and non-unitary fractions. |
| **1.11**<br>**Money** | Develop an awareness of South African coins and bank notes | □ Recognise and identify the South African coins (5c, 10c, 20c, 50c, R1, R2, R5) and bank notes R10 and R20<br>□ Solve money problems involving totals and change to R20 and in cents up to 20c | □ Recognise and identify the South African coins (5c, 10c, 20c, .50c, R1, R2, R5, and bank notes R10, R20, R50<br>□ Solve money problems involving totals and change to R99 and in cents up to 90c | □ Recognise and identify all the South African coins and bank notes<br>□ Solve money problems involving totals and change in rands or cents<br>□ Convert between rands and cents |
| **CONTEXT-FREE CALCULATIONS** | | | | |
| **1.12**<br>**Techniques (methods or strategies)** | | Use the following techniques when performing calculations:<br>□ drawings or concrete apparatus e.g. counters<br>□ building up and breaking down numbers<br>□ doubling and halving<br>□ number lines supported by concrete apparatus | Use the following techniques when performing calculations:<br>□ drawings or concrete apparatus e.g. counters<br>□ building up and breaking down numbers<br>□ doubling and halving<br>□ number lines | Use the following techniques when performing calculations:<br>□ building up and breaking down numbers<br>□ doubling and halving<br>□ number lines<br>□ rounding off in tens |
| **1.13**<br>**Addition and subtraction** | Solve verbally stated addition and subtraction problems with solutions up to 10 | □ Add to 20<br>□ Subtract from 20<br>□ Use appropriate symbols(+, -, =, □)<br>□ Practise number bonds to 10 | □ Add to 99<br>□ Subtract from 99<br>□ Use appropriate symbols(+, -, =, □)<br>□ Practise number bonds to 20 | □ Add to 999<br>□ Subtract from 999<br>□ Use appropriate symbols(+, -, =, □)<br>□ Practise number bonds to 30 |
| **1.14**<br>**Repeated addition leading to multiplication** | | □ Add the same number repeatedly to 20<br>□ Use appropriate symbols(+, =, □) | □ Multiply numbers 1 to 10 by<br>2, 5, 3 and 4 to a total of 50<br>□ Use appropriate symbols(+,×, =, □) | □ Multiply any number by<br>2, 3, 4, 5, 10 to a total of 100<br>□ Use appropriate symbols(×□) |
| **1.15**<br>**Division** | | **Number concept: Range 20**<br>□ Name the number before and after a given number.<br>□ Order a given set of selected numbers<br>□ Compare numbers up to 20 and say which is 1 and 2 | **Number concept: Range 99**<br>□ Order a given set of selected numbers<br>□ Compare numbers up to 99 and say which is 1, 2, 3, 4, 5 and 10 more or less | **Number concept: Range 1000**<br>□ Order a given set of selected numbers<br>□ Compare numbers up to 1000 and say which is 1, 2, 3, 4, 5 and 10 more or less |

| | | | | |
|---|---|---|---|---|
| | | more or less<br><br>**Rapidly recall:**<br>□ Addition and subtraction facts to 10<br><br>**Calculation strategies**<br>Use calculation strategies to add and subtract efficiently:<br>□ Put the larger number first in order to count on or count back<br>□ Number line<br>□ Doubling and halving<br>□ Building up and breaking down | **Rapidly recall:**<br>□ Addition and subtraction facts to 20<br>□ Add or subtract multiples of 10 from 0 to 100<br><br>**Calculation strategies**<br>Use calculation strategies to add and subtract efficiently:<br>□ Put the larger number first in order to count on or count back<br>□ Number line<br>□ Doubling and halving<br>□ Building up and breaking down<br>□ Use the relationship between addition and subtraction. | **Rapidly recall:**<br>□ Recall addition and subtraction facts to 20<br>□ Add or subtract multiples of 10 from 0 to 100<br>□ Multiplication facts for the:<br>□ 2 times table with answers up to 20<br>□ 10 times table with answers up to 100<br>□ Division facts for numbers:<br>□ up to 20 divisible by 2<br>□ up to 100 divisible by 10<br><br>**Calculation strategies**<br>Use the following calculation strategies:<br>□ Put the larger number first in order to count on or count back<br>□ Number line<br>□ Doubling and halving<br>□ Building up and breaking down<br>□ Use the relationship between addition and subtraction<br>□ Use the relationship between multiplication and division. |
| **1.17**<br>**Fractions** | | | □ Use and name unitary fractions in familiar contexts including halves, quarters, thirds and fifths<br>□ Recognise fractions in diagrammatic form<br>□ Write fractions as 1 half | □ Use and name unitary and non-unitary fractions in familiar contexts including halves, quarters, eighths, thirds, sixths, fifths.<br>□ Recognise fractions in diagrammatic form<br>□ Begin to recognise that two halves or three thirds make one whole and that one half and two quarters are equivalent<br>□ Write fractions as 1 half, 2 thirds, |

Below are the teachers' lesson plans which informed the researcher what lessons were to be taught and how they were going to be taught. This is where the researcher could see how teachers planned for the use of resources.

Grade 1 ( School A)

17 April 2015

| | |
|---|---|
| **COUNTING AND MENTAL MATHEMATICS/ CALCULATIONS** | Count out objects reliably to 50.<br><br> Give a reasonable estimate of a number of objects that can be checked by counting. |
| | **Count forwards and backwards in**<br> ones from any number between 0 - 100<br><br>**Count forwards in**<br> 10s from any multiple of 10 between 1 and 100<br> 5s from any multiple of 5 between1 and 100<br>2s from any multiple of 2 between1 and 100 |
| **CONCEPT TEACHING/ WHOLE CLASS/SMALL GROUP WORK** | |
| **Group lesson** | Use the following techniques when performing calculations:<br> concrete apparatus e.g. counters<br> draw pictures<br> building up and breaking down numbers<br> doubling and halving<br> number lines |
| | Number range: 1-10<br> Add up to 10<br> Subtract from 10<br> Use appropriate symbols (+, -, = , )<br> Practise number bonds to 7 |

Grade 1 ( school B) 28 April 2015

28 April 2015

Whole class counting

- Forwards and backwards in 1s (0-30)
- Forwards in 2s (0-30)

Whole class lesson and discussion

- Show and compare numbers 1-7 from smallest to biggest and biggest to smallest. Choose learners to stand in front with number flashcards.
- What number comes after 7? (8)
- Learners must show eight fingers. Show the learners that 8 can be shown in different ways with their fingers but will remain same amount.
- Show number 8 on the 100- chart.
- Write the number 8 in the air, on the table and on their friend's back.
- How many learners do we need to have 8 eyes?

Group work lesson

<table>
<tr><th>Group 3- Smarties (W)</th><th>Group 2- Astros (A)</th><th>Group 1 – Jelly tots (T)</th></tr>
<tr>
<td>Learners must count out 8 beads.<br>Make the symbol 8.<br>Learners must count out 8 sucker sticks:<ul><li>Take away 1 stick. How many left over? Take away 2 sticks, how many left over etc.</li></ul>Consolidation: DBE pg 74-75</td>
<td>Learners use one to one correspondence cards:<br>Match the number symbol, number name and number numerosity of 8.<br>Use chalkboards to:<ul><li>Write number symbol and name.</li><li>Draw 8 objects.</li><li>Cross out 1 object, how many left over? Cross out 2 objects etc.</li><li>Consolidation: DBE pg 74-75</li></ul></td>
<td>Each learner is given a <u>number house</u> card:<ul><li>Each house has 5 windows. Each window must add up to 8.</li><li>Learners must copy the work card into their books and complete.</li></ul>Consolidation: DBE pg 74-75</td>
</tr>
</table>

Grade 2 ( school A)

22 April 2015

| | |
|---|---|
| **COUNTING AND MENTAL MATHEMATICS/ CALCULATIONS** | Count to at least 150 everyday objects reliably<br> Give a reasonable estimate of a number of objects that can be checked by counting<br> Strategy of grouping is encouraged |
| | **Count forwards** and **backwards in:**<br> 1s from any number between 0 and 150<br> 10s from any multiple of 10 between 0 and 150<br> 5s from any multiple of 5 between 0 and 150<br> 2s from any multiple of 2 between 0 and 150 |
| **CONCEPT TEACHING/ WHOLE CLASS/SMALL GROUP WORK** | **Group *: NEW LESSON**<br>**Concept:** Halving and doubling. |
| **Group lesson** | Order whole numbers up to 99 from smallest to biggest, and biggest to smallest. |
| | Sums -20 |

**Grade 2 (school B)**

**29 April 2015**

| | |
|---|---|
| **Daily counting up to 180.**<br>**5 min** | Number Range: 0-120<br>Estimation of objects that can be checked by counting.<br>Grouping and counting of objects up to 50.<br>Counting forwards and backwards in 1s, 2s, 5s & 10s from any number between 0-100.<br>Homework DBE book pages 78-83 |
| **Mental mathematics**<br>**10 min**<br>**Whole class** | Number range: 0-50<br>Learners will use calculation strategies to add and subtract numbers up to and from 20, SA teacher pg 46.<br>Ordering a given set of selected numbers. |
| **Revision & new concept: (Class activity)**<br>**10 min** | Numbers operations and R/ ships:<br>Place value: Learners will use base 10 blocks, working in groups of four to show value of numbers and then ordering them from the smallest to the biggest. Page 20. SA teacher book.<br>Number names up to 30 & symbols up to 50<br>Place value: Learners add tens and units to find answers and draw tens blocks to show this 1.eg 10+2= etc. |
| **Group activity** | **Group 1 (Concrete)**<br>Learners count on from 20 using object, base 10 blocks, beads and tops.<br>**Problem solving**<br>Mum gave me 2 more marbles than my brother who has 24 marbles. How many marbles do I have? |

| | |
|---|---|
| | **Group 2 ( Representative)**<br>Learners work individually to complete a worksheet.<br>**Problem solving**<br>Mum gave me 2 more marbles than my brother who has 24 marbles. How many marbles do I have?<br>**Group 3 (Abstract)**<br>Learners draw groups of ten to show numbers 26-29 eg. 26 will be 2 groups of ten and 6 ones.<br>**Problem solving**<br>Mum gave me 2 more marbles than my brother who has 24 marbles. How many marbles do I have? |
| | Mathematics book 1 of 4 worksheets.<br>DBE workbooks<br>SA teacher's guide and workbook. |
| **resources** | Workbook DBE & Study and Master<br>Counting chart<br>Counters |

## Grade 3 ( school B)

## 30 April 2015

| | |
|---|---|
| Daily counting up to 180.<br>5 min<br>Whole class | **Number range:** 0-500<br>• Estimation of objects that can be checked by counting.<br>• Grouping and counting of objects up to 500 in groups.<br>• Counting forward and backwards in 1s,2s,3s,4s,5s,10s from any number between 0-5 |
| | **Number Range:**0-500 |
| | • Learners will use calculation strategies to double and halve numbers up to 20<br>• Ordering a given set of selected numbers.<br>• Comparing numbers and saying which is more or which is less 21 or 12, 14 or 24 13 or 31 etc.<br>• Recalling addition and subtraction facts up to 20. |
| **New concept: class activity**<br>**10 minutes**<br>**Number range 0-500** | **Numbers, operations & relationships**<br>• Use of number line<br>• Break down numbers into 100s, 10s and 1s<br>• Order numbers<br>• Problem solving, addition, subtraction, doubling, halving |
| | **Number Patterns**<br>• Sequence numbers from biggest to smallest and vice versa<br>• Give 5 numbers more than __<br>• Give 5 numbers less than___ |

| | |
|---|---|
| | • Number sequencing in 2s,3s,4s, and 10s and 100s |
| **Group Activity (not done last week due to interruptions)** | **Group 1(concrete)**<br>• Learners to count in multiples of 2s, 10s and 100s.<br>• Subtraction 10s and 1s<br>• Halving: 74, 68, 32<br><br>**Group 2 (Representative) a little bit of both**<br>• Learners use base 10 blocks<br>• 1s<br>• Halving: 48 64 36<br><br>**Group 3 (Abstract)**<br>• Learners work independently to complete work on the board<br>• Subtraction in 10s and 1s<br>• Halving 94 72 64 |

#### 4.4.3.2 Observation

The researcher collected data through non-participant observation. This means that the researcher was present at the scene of action, but not interacting or participating (James, 1997). The researcher found a place in each classroom where she could be a bystander, yet see and hear everything. This enabled the researcher to see what actually happened in the classroom.

Kawulich (2005:43) defines observation as “the systematic description of events, behaviours, and artifacts in the social setting chosen for study”. She says that observation enables the researcher to describe existing situations using the five senses, thus providing a “written photograph” of the situation under study. She further adds that “observation involves active looking, improving memory, informal interviewing, writing detailed field notes, and perhaps most importantly, patience”. It is a process that enabled me to learn about the activities of the teachers under study in their natural setting (classrooms) through observing them teaching mathematics using resources. Observation provides a context for the development of sampling guidelines and interview guides (Kawulich, 2005:43).

This method suited this study because the researcher wanted to see the whole process step-by- step and hear the exact words spoken, record the actions taken and view the resources that the teachers used to help learners understand. The researcher wanted to be present yet objective so as to gain a clear understanding of the situation. The method allowed the researcher to observe how resources were used to teach number concepts (or were not), and gauge participants' feelings from their speech, gestures and facial expressions. The researcher took pictures throughout the process as evidence of what was observed and to give the reader a visual image of what was observed.

The researcher observed two Grade 1 teachers, two Grade 2 teachers and two Grade 3 teachers in their classrooms teaching number concepts using the resources available. The teachers were asked to show in their lessons how they used resources to help learners understand particular number concepts.

An observation schedule was used (see Appendix B). The researcher wrote down everything that happened during the lessons regarding how resources were used. These field notes proved most helpful. Below are the notes on one of the lessons the researcher observed.

#### 4.4.3.3 Interviews

The researcher also used semi-structured interviews to collect data. These interviews helped to clarify what should have happened in relation to the lesson plans. A semi-structured interview comprises a set of questions to be answered by the participants, flexible enough to allow the researcher to ask more questions for clarity when the need arises (Fraenkel & Wallen, 2000:106). Semi-structured interviews are conducted orally and recorded by the researcher or someone who is trained to do so (Fraenkel & Wallen, 2000:106). The teachers were asked to explain what they use different mathematical resources for.

The researcher conducted one interview with each of the teachers. Delamont (2012:364) states that "we interview in order to find out what we do not and cannot know otherwise”. The disadvantage of using interviews, though, is that the presence of the researcher might cause the respondents to provide inaccurate or incomplete information, and they might answer in ways that correspond to what is socially desirable (James, 1997). The teachers might not be using mathematical resources in their classes regularly, and might only have done so on the day the researcher observed them; or they might not be using them in the same way when the researcher is not there. They might have also given the researcher answers that they thought the researcher was looking for, or answers that would not make them look bad.

Silverman (2011:134) points out that the researcher’s relationship with the respondents and the social categories that the researcher belongs to, such as age, gender, class and race, may affect the responses from the respondents. Respondents may respond honestly to researchers whom they know because they trust them and are comfortable talking to them. On the other hand, the respondents might not be fully honest for fear of being judged. These are the key questions asked: The number of learners, group teaching, the teachers’ qualifications and experience, the teachers’ challenges in teaching mathematics, their ability to communicate with the learners in the learners’ home language, what mathematical resources they have, how and when they use mathematical resources.

## 4.5 Data Analysis

According to Patton and Cochran (2002:23) data analysis is a process whereby the researcher draws out meaningful conclusions from the data collected. It is an on-going process based on what the researcher brings with her to the enquiry, what she pays attention to and selects out of what she is hearing and recording, and how texts are constructed (Butler-Kisber, 2010:30). The researcher needs to generate findings that transform raw data into new knowledge by engaging in active and demanding analytic processes throughout all phases of the research (Thorne, 2000:68). It is therefore important that the researcher understands these processes of reading, understanding, and interpreting the data.

### 4.5.1 Document analysis

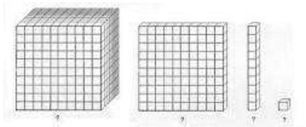
As mentioned before, document analysis is a “form of qualitative research in which documents are interpreted by the researcher to give voice and meaning around an assessment topic where data is processed through systematisation, categorisation and interpretation” (Yu et al., 2011:738). Document analysis incorporated coding content into themes, similar to how observations and interview transcripts were analysed (Administration methods, 2010).

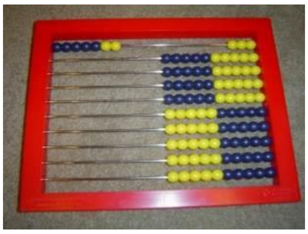
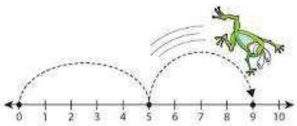
The researcher analysed 5 Foundation Phase teachers’ lesson plans. There were 2 lesson plans from school A (Grades 1 and 2) and three from school B (Grades 1, 2 and 3). The researcher used the CAPS document to see what should be taught in the Foundation phase in numbers operations and relationships (NOR). The researcher also looked at what was included or missing in the teachers’ lesson plans and what was added that is not in the CAPS document. Furthermore, the researcher looked at the resources included in the lesson plans and compared them to the resources in the CAPS document to identify similarities and differences.

### 4.5.2 Observation analysis

The researcher transcribed and analysed the parts of the data relevant to the research question (Flick, 2011:136). The researcher looked at teachers’ use of resources in terms of the following: How are they using mathematical resources in their mathematics lessons; what did they do and what did they say; which aspects worked well and which did not, and what might the reasons for this be. I also tried to see whether what the teachers had in their lesson plans was really what happened when I observed them in their classrooms. The following table served as a guide during observations.

Table 4.4 Observation on the use of resources

| Resources to be observed | Picture of mathematics resource | What should the resource be used for: | How teachers used the resource |
|---|---|---|---|
| Counters |  | Counting, addition, subtraction, making groups, loose ones, help the learners represent addition, subtraction, division and multiplication situations. | |
| base ten blocks (Diene's) |  | Develop the idea of a ten as a single entity. Reflects the relationships within our base 10 number system. Helps learners make sense of decomposition as a strategy for subtraction. | |
| number charts |   | Counting, number recognition, number patterns. | |
| number charts |   | Counting, number recognition, number patterns. | |
| number tracks |   | Counting on, back, shows the cardinal value of numbers. | |
| Flard cards |   | To show how numbers are constructed. Hundreds, tens, and ones. Can work alongside the bundles. | |

| | | | |
|---|---|---|---|
| Abacus |  | For grouping and showing loose ones. | |
| Number line |  | Help calculate and allow learners a way to record their thinking and to keep track of it. Allows learners to have a recording image they can use to explain how they solved a problem. | |

### 4.5.3 Interview analysis

Interview analysis involved re-reading the text and listening to the recordings several times in order to have a good understanding of the data while transcribing it (Orb et al., 2000). After transcribing the data, the researcher used a coding system to sort the data. Coding refers to identifying themes, ideas and categories and marking similar passages of text with a coding label to enable easy access at a later stage for further comparison and analysis (Gibbs & Taylor, 2010:1). The researcher identified parts that were relevant to the research question (Flick, 2011:136-37), and cut and pasted them in a different document. The researcher then used colours to highlight different themes that emerged from the data.

## 4.6 TRUSTWORTHINESS

The characteristics of qualitative data are known to be ambiguous and require the researcher to be on the lookout for emergent key themes for the data to be organised, arranged and interpreted (Burton, Brundett & Jones, 2011:147). Various issues may have affected the researcher's objectivity when reporting on the data. These may range from the fact that the research was conducted where the researcher taught, to the researcher's relationship with the teachers, to her not having the right tools to collect data. Though qualitative research can be used to identify a pattern or trend in a phenomenon being studied, there may be obstacles in the way of explaining the fundamental reasons for it, or whether it speaks directly for those participating in the research and thus represents their perspective (Burton et al., 2011:147). To minimise bias and to ensure that only what happened is what is reported, the issue of achieving trustworthiness and credibility will be discussed (Delamont, 2012).

## 4.7 TRIANGULATION

Triangulation is a process of verification that increases validity by incorporating several viewpoints and methods (Yeasmin & Rahman, 2012). According to Patton and Cochran (2000:29) one of the ways to ensure trustworthiness is by means of triangulation. Triangulation assumes that a variety of strategies are needed to fully understand and explain a problem (Patton and Cochran, 2000:29). To comply with this the researcher has used more than one teacher at two different schools in three different grades to collect her data. The researcher also used different methods to collect her data (document analysis, observation and interviews), hoping to obtain similar results.

Furthermore, investigator triangulation was used. This entails using different investigators and evaluators in assessing the study (Guion, 2002). Guion (2002) further explains that these evaluators are people within the field of study. As part of the requirements for Masters level study, one research paper was submitted to a journal, and reviewers' and editors' comments served to help validate the study.

## 4.8 CREDIBILITY

Credibility plays a big role in ensuring that a qualitative study is trustworthy. Credibility refers to establishing that the outcomes of qualitative research are credible or true from the perspective of the participants in the research (Trochim, 2006). Since in this perspective the purpose is to understand a phenomenon of interest from the participants' point of view, it is only the participants who are able to correctly judge the credibility of the results (Trochim, 2006). To be clear, there is no absolute way or truth in this type of research. Each individual comes with their own perspective, consequently the same experience may have different outcomes for different people

(Butler-Kisber, 2010:66). However, "[e]ach version of an experience and the perspectival nature of a shared experience does not lessen the plausibility of the representation if comprehensive and coherent" (Butler-Kisber, 2010:67). The way in which data is interpreted may differ from researcher to researcher, but the important thing is credibility, being able to justify why you have come to your perspective. Credibility attempts to address the question, "how congruent are the findings with reality?" (Shenton, 2004:64).

This study looked at teachers' use and understanding of different Mathematical apparatuses. The researcher used interviews and observation to find out the answers to the research questions. The researcher also tested (piloted) the interview questions on a teacher who was not part of the study to see whether the right questions were being asked to obtain answers appropriate to the purposes of the research. Interviews helped the researcher to gain information that could not be observed. The interviewees were also asked to read transcripts of dialogues in which they had participated. Shenton (2004:68) argues that this is one of the ways in which credibility can be addressed.

Furthermore, as part of the attempt to ensure credibility and trustworthiness, the researcher examined the data to determine whether the views expressed by the interviewers reflected the participants' experiences and opinions outside the interview situation, or whether they were merely a reflection of the interview situation (Silverman, 2011:366). There could be bias in the study from the teachers' (sample) side. The teachers may have been untruthful in the interviews and observations by showing the researcher methods they did not usually use and giving responses to avoid being judged by the researcher as a colleague.

## 4.9 TRANSFERABILITY

Trochim (2006) states that "transferability refers to the degree to which the results of qualitative research can be generalised or transferred to other contexts or settings". From a qualitative perspective, transferability is primarily the responsibility of the one doing the generalising. The qualitative researcher can enhance transferability by doing a thorough job of describing the research context and the assumptions that were central to the research. The person who wishes to transfer the results to a different context is then responsible for making the judgment of how sensible the transfer is (Trochim, 2006).

Reliability refers to the sense of being consistent, stable, predictable and accurate (Kumar, 2005:156). By showing similar results, the researcher will know that the interview questions and observations are reliable. Basically, reliability is concerned with whether we would obtain the same result if we observed the same thing twice. This is highly unlikely in qualitative research. Trochim (2006) explains that we cannot measure the same thing twice, and if we try, we are measuring two different things. It is therefore suggested that dependability is more appropriate in qualitative research. “Dependability refers to the need for the researcher to account for the ever-changing context within which research occurs” (Trochim, 2006). The researcher is responsible for describing changes that occur in the setting and how these changes may have affected the study.

### 4.10 CONFIRMABILITY

Confirmability refers to the standard to which the results could be confirmed or corroborated by others (Trochim, 2006). To achieve this, the researcher can document the procedures for checking and rechecking the data throughout the study. The researcher can also search and describe negative occurrences that contradict prior observations.

### 4.11 ETHICAL CONSIDERATIONS:

Ethical principles frame the purpose of the research and serve to maintain the rights of the research participants (Orb et al., 2000:93). Schnell and Heinritz (2006:21-24) propose a framework on principles of research ethics to ensure that the rights of the participants are protected throughout the research. Such principles are necessary to ensure that researchers make their research transparent, to avoid harming or deceiving the participants (Flick, 2011:216)

A letter requesting permission to conduct this research was sent to the WCED, the school principals and all participants (see Appendix C). The letter clearly states where the researcher is studying, what research is being done and what it entails. The letter also informs potential participants how they will contribute to the research (being observed and interviewed) if permission is granted. The researcher indicated that their identity would not be disclosed, assuring them that their names would not be mentioned anywhere and that they could stop taking part whenever they felt like it. Participating teachers were also be assured that the information obtained from the researcher's observations and interviews would be kept strictly confidential and that nowhere would their identities or the schools' names be revealed in the research project. All the participating teachers had to sign the letters of consent. The three main concerns covered in this explanation of ethical considerations are (i) codes and consent, (ii) confidentiality and (iii) trust. These are the basic and most frequently raised issues in ethical guidelines for research and by professional bodies in the West (Silverman, 2011:418).

### 4.12 SUMMARY

This chapter explained the aims and objectives of this research, locating it within the interpretive qualitative research paradigm using a case study approach. It gave a description of the research site, the sample and how these were chosen. It also explained the advantages, disadvantages and the logic behind the chosen methodology. The next chapter discusses the findings of the study.

# CHAPTER 5
# FINDINGS OF THE STUDY

## 5.1 INTRODUCTION

This chapter offers a discussion of the results from the data collected through the analysis of documents, lesson observations and semi-structured interviews. The chapter attempts to critically analyse the use of resources to teach numbers concepts in two schools in the Foundation Phase in Western Cape. The discussion will be based on analyses of the CAPS document, teachers' lesson plans, observations and interviews. This study makes extensive use of CAPS because CAPS should serve as a guide and starting point in planning mathematics lessons in South African schools. Furthermore, public school teachers as government employees are expected to follow and adhere closely to guidelines with respect to pedagogy, content and time spent on topics contained in the CAPS document.

### 5.1.1 Data analyses

Table 5.1 (CAPS, 2012:10) gives a clear indication of what number concepts entail in the Foundation Phase. It explains the content to be learnt by learners and what they should know when they leave the Foundation Phase. It describes how the content will be learnt by the learners while highlighting how number concept is developed. It also explains why certain activities are done in the Foundation Phase, which is important because teachers need to know why they are doing what they are doing in the Foundation Phase.

Table 5.1 Foundation Phase Mathematics Content Focus for numbers operations and relationships (CAPS, 2012:10)

| Content Area | General Content Focus | Foundation Phase Specific Content Focus |
|---|---|---|
| **Numbers, Operations and Relationships** | Development of number sense that includes:<br>• the meaning of different kinds of numbers,<br>• the relationship between different kinds of numbers,<br>• the relative size of different numbers,<br>• representation of numbers in various ways and<br>• the effect of operating with numbers. | The number range developed by the end of Grade 3 includes whole numbers to at least 1 000 and common fractions. In this phase, the learners' number concept is developed through working with physical objects to count collections of objects, partition and combine quantities, skip count in various ways, solve contextual (word) problems, and build up and break down numbers.<br>• Counting enables learners to develop number concept, mental mathematics, estimation, calculation skills and recognition of patterns.<br>• Number concept development helps learners to learn about properties of numbers and to develop strategies that can make calculations easier.<br>• Solving problems in context enables learners to communicate their own thinking orally and in writing through drawings and symbols.<br>• Learners build an understanding of basic operations of addition, subtraction, multiplication and division.<br>• Learners develop fraction concept through solving problems involving the sharing of physical quantities and by using drawings. Problems should include solutions that result in whole number remainders or fractions. Sharing should involve not only finding parts of wholes, but also finding parts of collections of objects. In this phase, learners are not expected to read or write fraction symbols. |

Schoenfeld and Kilpatrick (2008:1) agree that in order to improve mathematics teaching, one has to first find out and understand what the dimensions of proficient teaching are. Teachers need to know how knowledge is acquired and the different activities to support learning so that they do not just leave them out. (Leaving out certain processes is often the norm in the Foundation Phase, as teachers feel that there is not enough time or resources to complete them all). Mbugua, Kibet, Mthaa and Nkonke (2012: 87) agree that the workload of mathematics teachers may also affect the quality of teaching. They found that some teachers use the “lecture method” to teach because it is not time consuming and covers greater content.

The teaching of a secure number sense – the ability to use numbers flexibly and understand what numbers mean and their relationship to one another – enables learners to be competent and confident with numbers and calculations. In Grades R – 3, it is important that the area of Numbers, Operations and Relationships is the main focus of Mathematics (CAPS, 2012). Learners need to exit the Foundation Phase with both a secure number sense and operational fluency. For this reason, a large proportion of the time has been allocated to Numbers Operations and Relationships (CAPS, 2012). CAPS further instructs teachers to put more focus on number patterns when teaching patterns to consolidate learners’ number ability further. The entire time allocated to Mathematics in one day should be measured as one period. According to CAPS, each mathematics period covers whole class activity, small group teaching and independent work. In the lessons that were observed, teachers tried to incorporate whole class teaching, group teaching and independent work. Most of the teachers observed gave the learners work to complete at their tables. This came across as a strategy to keep them quiet and constructively busy while a small group was being taught on the mat. It also served as independent work rather than whole class teaching. Teachers explained that lessons do not always go according to plan.

### 5.1.2 Whole class activity

According to CAPS (2012), whole class activity or teaching is where the focus is mainly on mental mathematics, consolidation of concepts and the allocation of independent activities for at least 20 minutes per day at the start of the mathematics lesson. During this time the teachers work with the whole class to determine and record the name of the day, the date, the number of learners present and absent, and the nature of the weather. CAPS (2012) further explains that mental mathematics includes brisk mental starters such as – “the number after/before 8 is; 2 more/less than 8 is; 4 + 2; 5 + 2, 6 + 2”. During this time the teacher also consolidates concepts that are a little challenging. It is important that the teacher assigns the class their general class activity as well as independent activities that to do on their own while she gets on with the small group focused sessions.

### 5.1.3 Small group focused lessons

Small group focused lessons are most effective when the teacher assembles a small group of learners (8 to 12) with same ability level on the mat while the rest of the class is engaged in independent activities such as worksheets or DoBE blue work books as observed in the teachers' lessons (CAPS, 2012:13). Teaching is done orally and practically with the learners, engaging them in activities such as counting, estimation, number concept development and problem-solving activities which should be carefully planned. The findings of this study indicate that teachers are well aware that small group teaching is the best way to teach. This is why in each of the classes I observed teachers planned and taught in this way, while explaining that it was not always the norm as there was too much to cover in the given time. I also found that although the maximum allocated time for teaching mathematics is 8 hours a week, which amounts to 96 minutes a day, teachers spent more than 2 hours teaching mathematics. Clearly this was because there was an observer present who knew what was stipulated in the CAPS document. The Centre for Excellence in Teaching (CET) (1999:32) argues that it is good for teachers to be flexible and not adhere to a lesson plan rigidly because a lesson plan is simply a guide. Valuable learning opportunities will be missed if teachers fail to make adjustments based on how the class is learning.

In order to reinforce learning, written work (work book, worksheet examples, work cards) ought to be included in group sessions where possible (CAPS, 2012). Yerushalmy (2005:217) explains that work books, work cards and worksheets are being used for visualisation to achieve clarity and focus. This is because the ability to understand numbers depends largely on visual resources (Abramovitz, 2012). Visual language can be used to simplify challenging ideas, demonstrate deeper meaning or support collaborative thinking (Benn & Benn, 1998).

Teachers should take care not to underestimate slower learners, who should also be stretched. It is easier to match the difficulty level of the work to the learners if the group the teacher is working with is of approximately equal ability. However, mixed ability groups can work well for construction, measurement and patterning or sorting activities, or for games.

### 5.1.4 Independent activities

Independent activities are activities that learners engage in at their tables or desks (CAPS, 2012). These include worksheets and work book activities. Independent work takes place while the teacher is busy with a small group focused lesson. The rest of the class must be purposefully engaged in a variety of mathematical activities that focus on reinforcing and consolidating concepts and skills that have already been taught during small group focused lessons. Independent activities ought to be differentiated to cater to learners' different ability levels (CAPS, 2012). Independent activities may include both independent and small group focused lesson activities which must be observed (practical, oral), marked and overseen (written recording) by the teacher as part of her informal and formal assessment activities. These activities may include the close tracking of learners' responses (verbal, oral, practical, written recording) in learning and teaching situations, enabling the teacher to do continuous assessment, monitor learners' progress and plan support for learners experiencing difficulties with learning. The mathematics teaching and learning period should also provide enrichment activities for high achievers and general assessment activities (CAPS, 2012:13). Teachers can also include work book activities, graded worksheets/work cards for counting, manipulating numbers, simple problems in context (word problems) mathematics games like Ludo, dominoes, jigsaw puzzles; and tasks that involve construction, sorting, patterning or measurement (CAPS, 2012).

### 5.1.5 Learners with barriers to learning mathematics

"Barriers to learning mathematics" refers to the struggle some learners have with learning mathematics (CAPS, 2012). It is important for learners who experience barriers to learning mathematics to be exposed to activity-based learning. According to CAPS (2012), practical examples using concrete objects together with practical activities should be used for a longer time than with other learners, as moving to abstract work too soon may lead to frustration and regression. CAPS (2012) states that these learners may require and should be granted more time for:

- completing tasks;
- acquiring thinking skills (own strategies); and
- assessment activities.

The number of activities to be completed should be adapted to the learner without compromising the concepts and skills that are addressed (CAPS, 2012).

### 5.1.6 Mental mathematics

According to CAPS (2012:13) mental mathematics plays a very important role in the curriculum. The number bonds and multiplication table facts that learners are expected to know or quickly recall are listed for each grade (CAPS, 2012:13). In addition, mental mathematics is used extensively to explore the higher number ranges through skip counting and by doing activities such as ‘up and down the number ladder’. A teacher might give the following chained instruction: Start with 796. Make that 7 more. Yes, it is 803. Make that 5 less. Yes, it is 798. Make that 10 more … 2 more … 90 more … 5 less … and so on. CAPS (2012) states that these activities help learners to construct a mental number line. Mental mathematics therefore features strongly in both the counting and the number concept development sections relating to the topics Number and Patterns, and may also occur during Measurement and Data Handling activities. When doing mental mathematics, the teacher should never force learners to do mental calculations that they cannot handle – writing materials and/or counters should always be available for those learners who may need them. Findings in this regard will follow under lessons observed.

### 5.1.7 Recommended resources: Foundation Phase mathematics classroom

One of the recommended resources to teach number concepts in the Foundation Phase are counters (CAPS, 2012). Learners use counters such as bottle tops and ice-cream sticks as concrete materials for counting and solving problems (CAPS, 2012). According to CAPS (2012:118), counting is an important component in helping the learners to develop an awareness of the size of numbers and lays the basis for calculating with whole numbers. Counting helps develop the following skills in the Foundation Phase:

- Counting all
- Counting on
- The cardinality principle
- Working with written texts.

CAPS (2012) recommends the use of a large die, big counting frames, height charts , big 1 – 100 and 101 – 200 number grid posters (100 – charts), and different number lines (vertical and horizontal), to enhance the skills mentioned above. Fundamental number concepts are developed by counting real objects. Learners learn to associate number words with a collection of objects, to build a mental picture of what a number means, how big it is, and that the number name of the last object counted represents the total number of objects in the group. CAPS (2012:118) insists that in order for learners to be able to count objects, they need to be granted opportunities to practice counting orally. Learners need to have an oral list of number names in order: one, two and three. CAPS also recommends that learners be encouraged to say number rhymes and play mathematical games, like Snakes and Ladders or dominoes, that reinforce the oral counting. This ability to count orally or rote count is important to develop the knowledge of number names and also a sense of the rhythm/pattern within numbers.

Learners need to be presented with visual images of numbers in sequence using resources such as number lines and number tracks. Number lines allow learners to experience the ongoing number system while helping them with the sequencing of numbers. In Grade 1 the number line can be supported by a string of beads put above the number line to help learners count. After counting single objects and counting in ones, learners can be introduced to counting in groups of 2, 5, 10, 20, and counting all, using resources in the form of concrete objects such as an abacus and string of beads. According to CAPS (2012) these resources help create understanding for learners as they are able to touch and see the objects they are counting; later on, learners will use these resources to calculate. The concept of the “jumps” can be learnt by using fingers or by constructing a line outdoors and physically jumping from one number to the next.

Dienes blocks can be introduced to develop the idea of a ten as a single entity and that 10 ones make 1 ten and 20 ones make 2 tens. Flard cards are place value cards that may be used to show how numbers are constructed, and should be used alongside bundles or groups of objects (CAPS, 2012).

## 5.2 FINDINGS BASED ON DOCUMENT ANALYSIS

The teachers all used different lesson plan formats. This showed that they did not engage in planning jointly as a phase. Furthermore, the lesson plans were not always followed, due to several common factors such as interruptions, time constraints and lessons not unfolding as anticipated. Ollerton (2004:13) maintains that the teaching of number concepts is guided by the learners and not by the prescribed curriculum or rigid planning. This means that the teacher’s planning should reflect the actual progress made by learners, regardless of what the curriculum stipulates. The Grade 3B teachers explained that:

“it’s interference from the SMT [school management team] not just the SMT but other programs at the school. Fundraising included which I find ridiculous and too much. So it sort of interferes with the lesson plan. Sometimes it’s necessary to go back when the children don’t understand.”

The Grade 1B teacher answered:

“You will always expect that 1 child that needs extra help with, like repetition of a concept or there’s children that fight cause they don’t wanna share the counters or it can be many, many things. Sometimes I’ll be on the mat with the children and maybe

I didn't think of maybe the child asking this one particular question or needing me to explain a part of the concept and that would take like a extra 15 minutes from what I had planned on the lesson plan. So actually I don't think it actually ever goes according to plan actually."

The Grade 1A teacher concurs:
"Sometimes maybe a learner is uhm maybe we doing number 12 but there's one learner or two learners in a group that actually cant concept the number 12 or can't even do sums or even count on to twelve and then I've gotta go back to get them to that understanding before I can move on."

The Grade 2A teacher said:
"because uh, when we prep, we prep to do a certain lesson for that particular day or for the week. But sometimes you find you prep something for Tuesday but you didn't really reach your goal in Monday's lesson so you go back. So sometimes you got to go back to that lesson. Sometimes you prep for the whole week and find that on Wednesday I'm still doing Monday and Tuesday's prep." Although one would argue that contact time should be protected and respected at all times, the reality is that it is not. Teachers are expected to be flexible and go in whichever direction the school demands, but then sort out the repercussions on their own. WCED clearly states that contact time spent on other activities should be replaced by extending the day and dismissing the learners later.

**Grade 1A lesson plan**

The lesson plan had the number ranges for counting and calculating. The new concept to be taught was addition and subtracting from 1 to 10. The teacher did not tick the techniques to be followed in this lesson, therefore I assume that all the listed techniques - concrete apparatus, draw pictures, build up, break down numbers, doubling, halving, and number lines will be used in the lesson.

**Grade 2A lesson plan**

The lesson plan had the number ranges for counting and calculating. The concept to be taught was halving and doubling but the number range was missing and the resources or "how" doubling and halving would be taught was not mentioned. Detail was missing in this lesson plan.

**Grade 1B, 2B, 3B lesson plans**

These lessons were quite similar in content. Although their formats were diffrent, they were comprehensive and detailed. There was a clear indication of what the whole class would be doing as well as what the smaller groups would be doing. The group work was differentiated, the different groups' activities were clearly stated as well as the additional activities for each group. The resources to be used in the lessons were also clearly indicated. One would pick up these lesson plans and know exactly what and how to teach.

A lesson plan is a central aspect of a teacher's effectiveness in designing and implementing teaching that promotes learning (Centre for Excellence in Teaching, 1999:29). It seems that although the teachers plan their lessons, adhering to their plans is not always possible, owing to factors ranging from learners' inability to understand as promptly as the teachers expected them to, to administration duties and other interruptions from the school.

## 5.2 FINDINGS BASED ON LESSONS OBSERVED

This section deals with the findings arising from the mathematics lessons observed. It gives a detailed explanation of how five different teachers used resources to teach number concepts in their classes.

### 5.2.1 Lessons from Teacher 1A, school A (Grade1)

In Grade 1A, learners were given a number line and kokie pens (as illustrated below) and asked to make a dot on the number 2 while the teacher demonstrated on the big number line. The focus of the lesson was to teach learners to add and subtract using a number line with the number range 0-6. According to CAPS (2012) using number lines helps learners to record and keep track of their thinking. Learners also produce a recorded image that they can use to explain their solutions to problems (CAPS, 2012:125). Making the dot with a kokie as instructed by the teacher helps the learners to see where they started. The teacher then pointed out that the learners were at the number 2 and if they needed to get to 6, they had to do hops. The hops had to be done with a pencil and not with kokie pens. Thompson (1994) explains that what learners need to understand and see is not in the material, but rather in using the material as a resource to understand a concept. This is why the teacher explained the process step-by-step and recommended the use of a kokie pen so that the starting point could stand out for the learners. The teacher then explained how the learners had to go to each number and that they could not just jump to number 6 but had to count while hopping.


Figure 5.1 A learner shows how to get to 6 from the number 2

Figure 5.1 depicts how a learner hopped to get to the number 6 from the number 2 using a horizontal number line. Learners were instructed to use the number lines in their books to hop from 2 to 6 after the teacher explained and demonstrated how to hop. One of the learners was then tasked to show how they hopped in their books on the big number line using chalk. The picture shows that the learner had hopped correctly and stopped at the correct number. The teacher then looked around and saw that some of the learners had made more hops than asked. This signified that the concept was not fully understood by the learners or that the teacher's instructions were not clear or understood. While some learners grasped the concept, others did not. Realising this, the teacher then told the learners to count the hops that the learner made on the board and then count their hops to see if they had made the correct number of hops. The teacher tried to help the learners who had more hops by counting and demonstrating on the bigger number line on the board.


Figure 5.2 The teacher attempts to intervene after learners showed signs of not understanding

It seemed that there were still learners who did not understand how many hops had to be made or how the hops worked. This was maybe because the teacher did not explicitly explain how the hops work. Learners need to know that they should not start counting on the number on which they will depart from. They should be taught that one can only start counting once a full hop has been made: "When using the number line as a calculating image, the concept of the 'jumps' can be learnt by using fingers or by constructing a line outdoors and physically jumping from one number to the next" (CAPS, 2012:125). Figure 5.2 shows that the teacher is aware that the concept of calculating using a number line can be learnt by using fingers because after the learners showed signs of not understanding, she used her fingers. The only problem here is that she did not give the learners the opportunity to do so. She continued by asking the learners what number they started at and the learners answered 2. She then wrote 2 on the board and asks how many hops did we make? Learners answered 4. Teacher added 2+4 and asked what number did we land on and the learners answered 6. Teacher wrote 2+4=6 and asked learners if they could see how they can use number lines to do sums. Learners said yes, and teacher asked if 2+4 is really 6 and learners said yes.

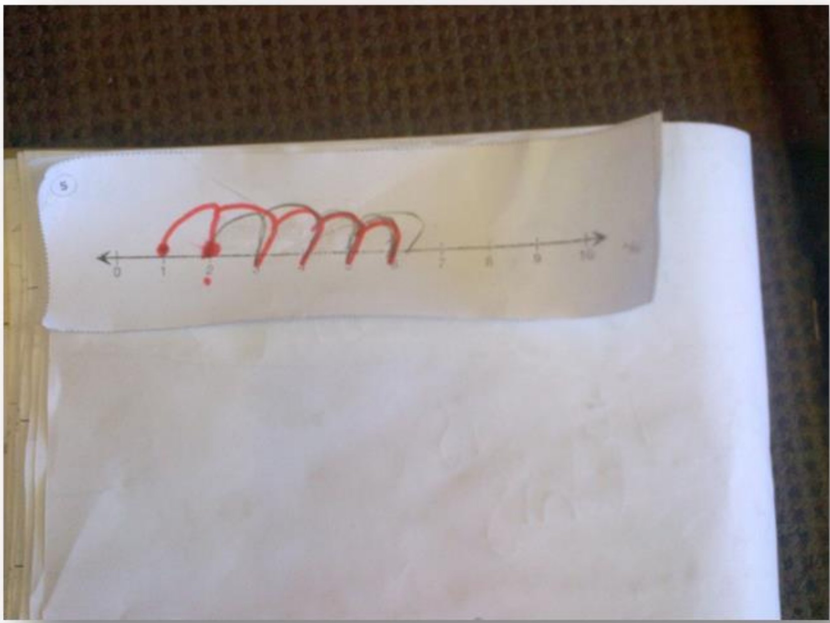


Figure 5.3 A learner gets confused after copying from the board

Learners were asked to do the same but on their own. Learners were told to get to 6 again but had to start at 1 using their kokie pens to make a dot at number 1. Learners used the same number line and the same colour kokie pens. They started getting confused and decided to copy what was on the board, but they were then told to erase what they had copied from the board. The teacher realised that she should have given the learners another number line because it was difficult to distinguish two sums on the same line. She consequently handed out a second number line and learners were told to start at number 3 and stop at number 6. Learners were told to hop all the way to number 6. The learner who struggled did much better then. This, however, did not prove that the learners understood. Research suggests that showing and telling learners what to do may get teachers their intended outcome, while the learners could be “mindlessly following what they see” (Van de Walle et al., 2010:29).

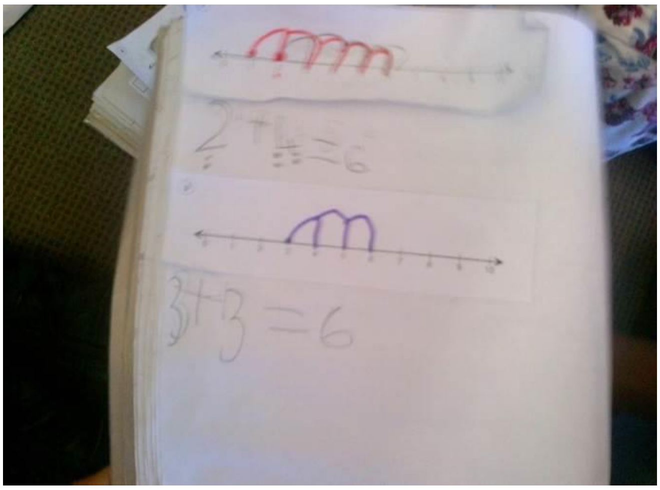



Figure 5.4 A learner’s work after following the teacher’s instructions

Figure 5.4 shows a learner’s work after more explanation from the teacher. The teacher drew a minus sign on the board and asked if the numbers were going up or down showing the direction on the number line using her hand to indicate up and down. She asked which sign should she use, – or +? The teacher asked the learners whether the numbers were going up, while she pointed at the addition sign +, or down, while she pointed at the minus sign –. The learners replied up +. The teacher went through the same process with 3+3=6. Some learners wrote +3=6 while some wrote +3 only. The teacher showed them on the board what the sum was. The learners got a third number line and were told that they were going to do a special sum. The learners were told that they were going to start at number 6. They were told to start at 6 and stop at 6. “*So what number do we use when we do not hop*?” Learners answered 10. The teacher replied “No”. The learners suggested various numbers until the teacher showed them on the board and wrote 6+ and asked them, “Did we make hops? So what is that number? What is that round number?” The learners answered 0. Teacher then wrote 6+0 and asked “what number did we stop at?” The learners answered 6 and the teacher wrote 6+0=6. The learners were asked to complete that last sum and went to their tables when they were done.

### 5.2.2 Lessons from Teacher 1B, school B ( Grade 1)

The teacher started with a whole class lesson, counting forward and backward from 1-30. She explained to learners that they were going to count from 1 to 30. She asked one learner to show on the big number chart on the board where the number 30 was. Learners counted in 1s from 1 to 30. The teacher then told the learners that they were going to start at 30 the next time. She explained that they were going to count backwards. She used the word “reverse” to be more explicit. The teacher also used the term “red robot” for the number at which the learners had to stop counting (30). Learners then did the same but counted in 2’s. Oral counting is important, before learners count objects they need opportunities to practice counting orally (CAPS, 2012). According to CAPS (2012:118) “counting assists learners to develop an awareness of the size of numbers and lays the basis for calculating with whole numbers”. Being able to count orally or rote counting helps to develop the knowledge of number names and patterns within numbers (CAPS, 2012).

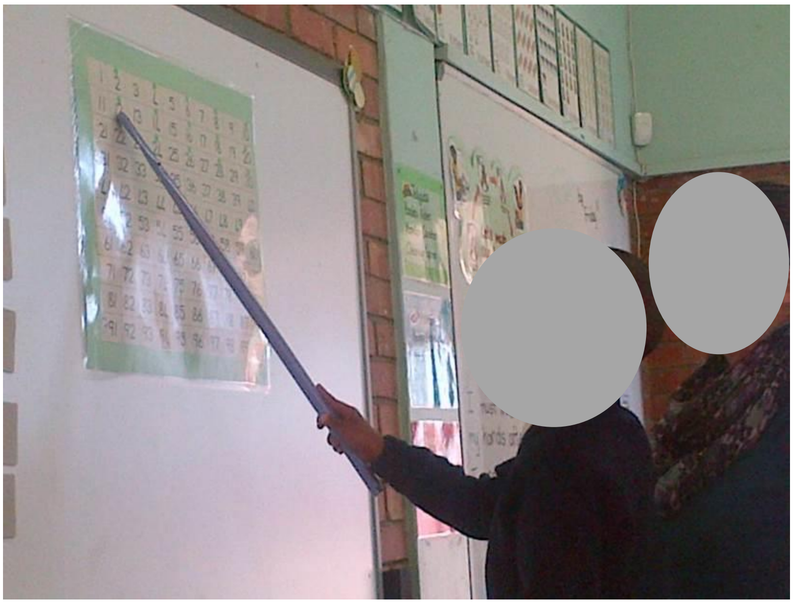


Figure 5.5 Learners’ use of a chart for counting and skip counting

Figure 5.5 shows how the teacher got a learner to point at the numbers while the other learners were counting. This helps the learners match the number names to the symbols. It also shows learners how numbers are written and how many digits make certain numbers; for instance, thirty-four is written 34 and not 304. After counting as a whole class the teacher instructed the smarties group to go to the mat. Each learner in the smarties group was given a number card ranging between 1-7. She then instructed the seated learners to say the numbers of each child she touched. Learners said the numbers as the teacher touched them. She praised the learners by saying “Well done”. The teacher then asked the ones who were sitting to arrange the numbers in the correct order from the smallest to the biggest. The learners answered out loud who had to stand where, based on the number they held. The teacher used the words ‘after’ and ‘order’ so that the learners could learn and understand the correct mathematics vocabulary. She asked questions such as: “Who’s after a certain learner?” She then let the learners face the other way and reshuffled them. The reshuffled learners turned around to face the learners who were sitting and they said the numbers. The learners were reshuffled again, but then the ones who were sitting had to order the numbers from biggest to smallest. The teacher asked “Who has the biggest number? Who comes next? What number does he/she have?” Figure 5.6 shows the activity of learners ordering numbers 1-7 in the correct order.

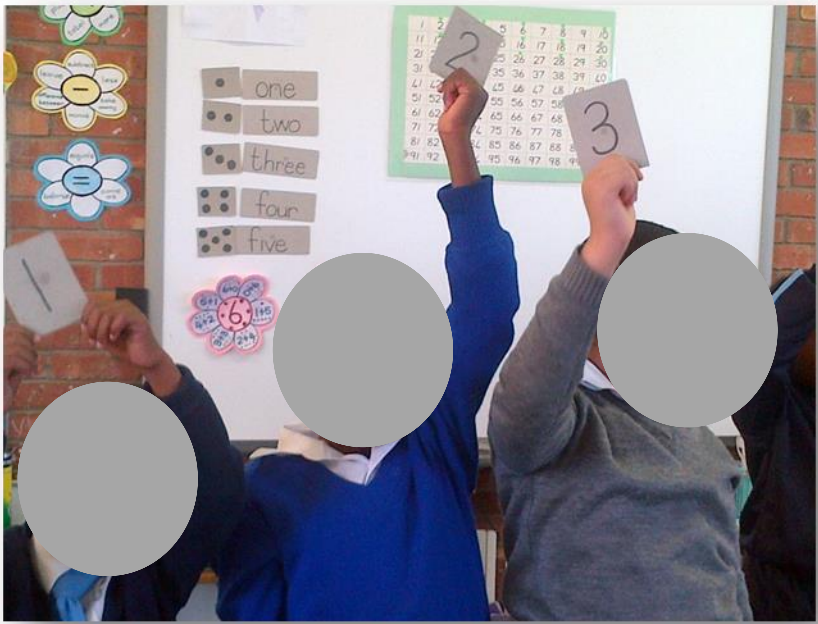



Figure 5.6 Using learners as a resource to order and compare and order numbers

Figure 5.6 depicts learners standing in order from 1 to 7. Learners said the numbers from biggest to smallest. 7 is the biggest number. The teacher then introduced number 8. She asked the learners which number would come after 7. The learners answered “number 8” and one boy who was standing on the side with the number 8 joined the line and stood after the learner with number 7. This teacher understands the importance for learners to count single objects and matching number names to sets of objects (CAPS, 2012:118). According to CAPS learners need to touch and move objects while saying the number name. This helps them understand that the last number called signifies the last object counted in the group. They need to know “that the last number said indicates the amount in the set or the cardinality of the set” (CAPS, 2012:118). In this lesson, instead of using objects, the teacher used the learners themselves to represent the one to one principle. This principle stresses the significance of allocating only one counting label to each counted object in the collection (Marmasse et al., 2000:3-4). The teacher also brought in the abstraction principle. The awareness of counted items is reflected in this principle. The teacher had made the learners understand that counting can be applied for any set of objects. The objects do not have to be the same. They can differ in colour, shape and size (Marmasse et al., 2000:3-4).


Figure 5.7Teacher introduces the number 8

The teacher told the learners that they were going to be busy with the number 8. She asked one learner to point out the number 8 on the board. After the number 8 had been displayed, the learners were then asked to indicate 8 on their fingers. The teacher explained that there were different ways to make 8 with their fingers, and asked three learners to stand in front and show the class the different ways to make 8. The learners counted their fingers to make sure it was 8. They drew 8 in the air. They drew 8 on the tables with their fingers. They drew 8 on each other's backs. The teacher was aware that learners need to be actively involved when introducing mathematical concepts. It seemed that she understood the need to teach mathematical methods and language through a variety of appropriate experiences and research-based teaching strategies (NCTM, 2013:1). This would broaden the learners' understanding of the number 8 and allow them to work confidently with the number. Learners should be allowed to use a variety of resources so that they do not form misconceptions based on experiences with limited resources (Drews, 2007:22). The teacher then asked, "How many eyes does one person have?" The class answered "two". So she asked, "How many learners must stand in front to make 8 eyes?" One learner answered "eight". Teacher called 8 learners to go to the front and the learners counted aloud. The learners could then see on their own that 8 learners did not have 8 eyes. The teacher encouraged the learners to count in 2s. The learners came up with different possible numbers. The teacher kept the same number of learners on the mat and the class counted until they realised that the answer was 4 and got it right. The teacher did not show the learners the correct answer, but rather allowed them to learn from their mistakes and experience the process of getting to the right answer. The teacher then asked how many children made 8 eyes and the learners answered "four". The teacher used different ways to ask the same question, encouraging learners to think. The emphasis was on concept development rather than process or rote memorisation (Abramovitz, 2012). Concept development ensures being able to apply knowledge and knowing when to use different resources in various situations. The teacher then told the smarties group (10 learners) to go to the mat while the others handed out blue books. She attended to the learners with blue books and told them which page to turn to while the learners on the mat took turns to take out 8 blocks from a tub/container. Figure 5.8 shows how learners counted as they took the blocks out of a container.

Figure 5.8 Counting using single blocks

Each learner sat with 8 little blocks. The teacher instructed them to count the number of blocks they had, one at a time. She then put the number 8 in the middle of the mat where all the learners could see and asked the learners to make the number 8 with their blocks (number symbol). The learners struggled to make 8 with their blocks. Then the teacher told them to make a small 8 since there would not be enough blocks to make a big number 8. The teacher then demonstrated and made her own 8, because the learners were struggling on their own. Figure 5.9 shows how a learner is attempting to form the number 8 with blocks while looking at the teacher's demonstration.

Figure 5.9 Learners use blocks to form number 8

The teacher then gave the learners a tub with sticks and told the learners to take out 8 each. Learners then started making the number 8. The teacher told them that that was not what she had instructed them to do, and that they just had to count the sticks. Learners counted the sticks and then the teacher instructed them to remove one stick. Learners did as instructed and the teacher asked them how many were left? The learners answered correctly. The teacher then asked them to put the eight sticks together again and take 2 away and then count the remaining amount. Learners answered correctly and said 6. The teacher told them to take away 4 and count the leftover sticks. Figure 5.10 depicts learners using resources in the form of sticks to count 8 objects.

Figure 5.10 Learners use sticks to count 8 objects

Figure 5.11 shows the activity that the learners were instructed to do at their tables after having worked with number 8 on the mat.


Figure 5.11 The use of the department of education blue books as consolidation of work taught

This teacher understands the importance of following the correct steps when teaching young learners. She first gave the learners the opportunity to use various concrete materials, then afterwards assigned them semi-concrete activities involving pictures of objects in their blue books. Going through these steps would make the tasks related to abstract work much easier and more understandable. Mathematical concepts should be separated into hierarchical components to enable learners to be in control from one component to another while possessing a perfect knowledge of the previous components (Ojimba, 2013:46).

The teacher took a different group, the “Astros” (10 learners), and gave them cards with either a number symbol or a number word. Here it was clear that this group was more advanced than the previous one because the teacher did not use concrete materials with this group but rather semi-concrete materials from the outset. Some of the learners had cards with the word 8 and some with the symbol 8. Teacher asked the learners; “Who has the number 8?; who has the word 8?” Learners indicated by putting up their hands. They were then told to find a card that matches theirs. The teacher then handed out dot cards. The dots on the cards were placed differently. The teacher asked the learners to count the dots on the cards. Learners counted 8. The teacher asked “What is the same with all the cards?” Learners said “8”, they all have 8 stickers”. The teacher asked “What is different?” and she then gave the learners other cards with the outline of the stickers to match those with the dots cards. The learners began to understand that no matter how the dots were placed, they still represented 8. This is called conservation and is one of the crucial steps in understanding the number system (CAPS, 2012).

Subsequently, the learners got a board and chalk to write the number symbol 8 and the number name eight. Then they were asked to draw any 8 objects or pictures. The teacher asked one learner to count how many he had. He counted 7 and the teacher told him to draw one more. The type of activities in this teacher’s lesson indicated that she consults and follows the CAPS document. Figure 5.12 shows one of the learners drawing 8 objects and writing the number 8.


Figure 5.12 Learners instructed to draw 8 objects

The teacher told the learners to take one of the drawn objects away and count how many were left over. They did this, then took away 2 and counted how many were left over. The teacher then told them to take away 5 and count how many were left over. They took away shapes by drawing a line through them with their chalk. The teacher took the last group on the mat. Each learner got a house with number 8 on top. The teacher told the learners to count the windows of their houses. They all had 5 windows. One side of the window had dots and the other had none. The teacher explained that each row had to have 8. The teacher then asked: “So how many must be drawn in each row to make 8?” Learners took the cards to their seats as work cards to write the sums (number sentences in their books). They copied the houses with the dots into their books. In their books lines like those on the cards were drawn by the teacher. So the learners had to draw the dots and write the number 8 on top. Although CAPS recommends certain resources to be used in class, teachers may also use other resources or create their own to help learners when teaching mathematics concepts. Figure 5.13 shows one of the self-made work cards that the teacher used.

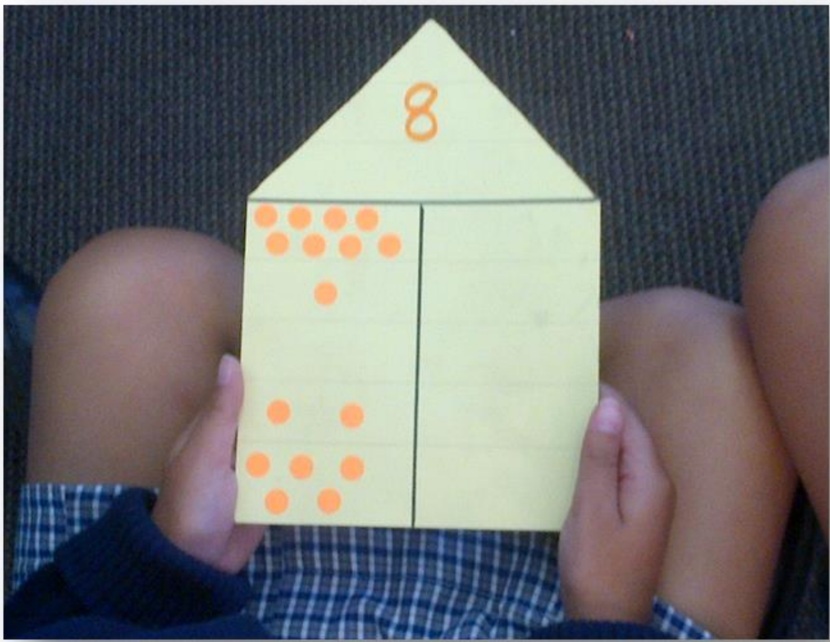


Figure 5.13 Number 8 work cards

### 5.2.3 Lessons from Teacher 2A, school A (Grade 2)

The teacher started the lesson with a whole class activity, “Today is, tomorrow will be [the date], this year is [ ],” and the learners had to answer. The teacher then asked “What do we always write after April?” The learners answered “Twenty fifteen” (2015) and the teacher said “Yes, two thousand and fifteen”.

The learners were instructed to say the days of the week and months of the year. The teacher asked which month comes after April, and one learner had to respond. The learners answered all altogether at the same time, shouting March. The teacher corrected the learners and explained the before and after concept. By then the learners had answered incorrectly twice. They had said “twenty fifteen” and that after April comes March. The teacher verbally explained what was before and after. She did not show the learners that twenty and fifteen add up to 35. She could have used her set of flard cards to show the learners why we should not say twenty fifteen. She could also have shown the learners the concept of ‘after’ in a practical way, because it seemed that they had not been adequately introduced to the concept.

The learners then counted on the counting chart in tens, starting at number 10 and going up to 200. The teacher told learners that the number was getting bigger and bigger by 10. The teacher then tasked the learners to count backwards in 10s. She called upon one learner to count while she pointed to the numbers. The learners then used a different chart on the board to count in 2s. The teacher helped the learners by pointing at the numbers. This activity did not actually promote any thinking as such. There was no real need for the teacher to point at the numbers while the learner was counting in 2s as the chart that was used only contained multiples of 2. The teacher could have used a normal chart with all the numbers on it so that the learners could see the different patterns and learn and practice skipping numbers. The teacher then asked one learner to count in 2s starting at any number. She asked one learner to count in 2s starting at 74. The learner counted while the teacher pointed at the numbers. Again, pointing at the numbers 74, 76, 78 while the learner was counting was like just telling the learner which numbers to say. Van de Walle et al. (2010:29) caution that the use of resources does not necessarily mean that constructive learning is taking place. The teacher appears to have not used the number chart effectively as a resource, telling learners exactly what to do and what to say. As said before, this teaching style does not promote understanding but rather rote or instrumental learning. The teacher then asked one learner to count backwards starting at 28.The teacher did the same with a number chart with multiples of 3 and asked the learners to count in 3’s. The teacher then asked one learner to count in 3’s while she pointed to 3, 6, 9. Figure 5.14 shows the number charts that were used to count in multiples of 2 and 3.

Figure 5.14 Number charts used to count multiples

The learners were then instructed to read number names saying, number name 6, word six, number name 7, word seven. They recited this number name and word sentences till they got to number 10. The teacher then gave the learners sums on a chart to read. The chart had sums (number sentences without answers) and the learners had to provide the answers. It seemed as if there was no real structure in this class. The learners were doing a bit of counting, then a bit of sums. The lesson plan was not followed and the focus was not clear.

The teacher then asked the learners to answer number sentence sums, one at a time, and told them to stand if they did not know the answer. This seemed unfair because the learners were not even given enough time to think about the number sentence. It was embarrassing for them to have to stand just because they did not know the answer. The teacher then did mental mathematics: double 5, half of 20, half of 40, 60, 100. The learners answered in chorus so the teacher could not tell who knew the work and who did not.

The teacher then told the learners to go back to their tables in groups, first the red group then the yellow group. The yellow group was given a worksheet dealing with counting even numbers, counting the number of children hiding behind trees and doubling and halving. The teacher called the green group to the mat and gave each learner a pack of flard cards. The teacher handed out a page with number lines and told the learners that they were going to be adding 10.The teacher asked the learners to take out number 10. The teacher used her own pack to ask the learners to identify all the 10s as she flashed them to the learners. The teacher instructed the learners to lay out the 10s: 10, 20, 30, 40, 50, 60. She then told the learners that they must add 10 to given numbers. The use of flard cards was appropriate as the flard cards clearly showed the learners which column changed when a 10 was added.

Figure 5.15 Learners use flard cards for place value

The teacher then, while learners were laying out their cards, took her flard cards and started asking questions about the number 27 that she had in her hand. The teacher asked “Which number is bigger, the 2 or the 7? They answered that it was 7 and the teacher consequently told them that the 2 was not actually a 2, but a 20. The teacher talked incessantly depriving the learners of the opportunity to discover anything for themselves. She could have given the learners an opportunity to extract the number 27, and then posed questions, allowing them the space and opportunity to think, rather than explaining all the time. She then used her flard cards to show the learners the number 27 broken down to 20 and 7. She asked the learners which number is the biggest. The learners said 20. When the numbers were put back together, the learners still said 7 was bigger. That might indicate that the learners did not actually understand the concept of place value. As stipulated in the CAPS document (2012), the teacher should have used bundles of sticks together with the flard cards, as this would have allowed the learners to clearly see the numerosity (value) of 20 objects compared to 7 objects. The teacher merely discussed this, decomposing the number and asking how many tens were in 20, before she put the number back together and reminded them again that 2 was 20 (2 tens) and 7 was 7 ones or units. “So which one is bigger? 20 or 7?” The teacher asked, and the learners replied correctly, saying 20. Although learners could touch and move flard cards, flard cards remained an abstract resource, because the learners only observed numbers and not objects as such. The teacher could possibly have used a concrete or semi-concrete resource such as bundles of ten or the diene's blocks together with the flard cards, because the learners seemed not to have understood place value. Figure 5.16 shows how learners engaged with the flard cards.

Figure 5.16 Learners lay out different numbers using tens and ones (units)

As can be seen in the picture, the teacher did not ask the learners how specifically to pack out the flard cards. This is a crucial step because it could have show the learners the different positions and places of numbers from right (ones) to left (tens, hundreds). The teacher gave another number, '34', and did the same. She then asked the learners what plus sum they could make with 34. The teacher broke up the flard card into 30 and 4 and one learner answered 30+4. The learners were given more sums. They were given 10+4 and answered 14, 10+2, 10+1, etc. The learners were not adding 10, they were adding ones (units) to 10 (+1, + 2, +3). Then the teacher gave 10+4, 14+10, 24+10 and the learners answered correctly every time. The teacher told the learners that the numbers were increasing by 10. These types of activities were observed not to be at the level of the learners, because clearly they did not understand the concept of place value and needed more opportunity to engage with the concept. Figure 5.17 depicts the teacher demonstrating to the learners how to lay out a specific number using flard cards.


Figure 5.17 Teacher models how to pack out a number using flard cards

The teacher gave the learners different sums to do on the number line. She placed an example of 10+7 on the board and showed the learners how to do it on the number line. Some of the learners did not seem to understand and just copied what the teacher was doing on the board. Some did exactly what they were told and used the sum that the teacher verbally gave them. It was clear that most of the learners did not understand what was happening and were generally just following the instructions given by the teacher. It seemed that the teacher might not have understood that the emphasis should have been on concept development rather than simply on procedures or rote memorisation (Abramovitz, 2012). The knowledge that learners need to visualize, understand and acquire lies not in the material itself, but rather in how to use the material as a resource to understand a concept. It is therefore important that the teacher knows what materials to use, when to use them and how, as this is important in helping children understand the mathematical concepts being taught. The learners were then told to pack away their flard cards and do one activity at their tables. The activity was written on the board and learners had to copy from the board. Figure 5.18 shows how the learners were adding ones to the number ten. All the number lines started at 10. The concept taught was 10+ rather than +10. One needs to bear in mind that the teacher had more than 20 years of experience teaching in the Foundation Phase so she might have been confused. Figure 5.19 shows how the teacher demonstrated to the learners how to add 10 using a number line (though actually showing them how to add 7 to 10).

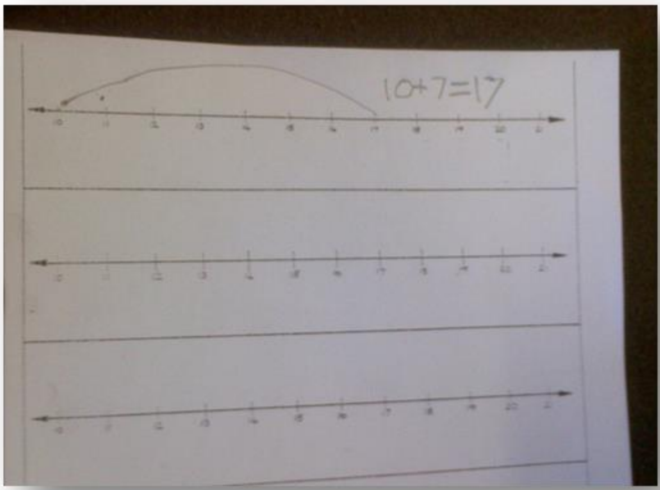



Figure 5.18 The learners copy the number sentence10+7=17 from the board


Figure 5.19 The teacher demonstrates the use of number lines to add 10

### 5.2.4 Lessons from teacher 2B, school B (Grade 2)

The focus lesson was place value but the teacher started her lesson with a whole class activity. She started by asking “What is the double of 8?” and asked a learner to show on the number line how to double 8. The learners started at number 8 and counted 8 more. The teacher repeated the specific action and asked the learners to count aloud so that the other learners could also hear. The teacher explained that that was how a person was supposed to do doubling. Figure 5.20 shows how a learner did doubling using a number line while the rest of the learners counted aloud with the learner.

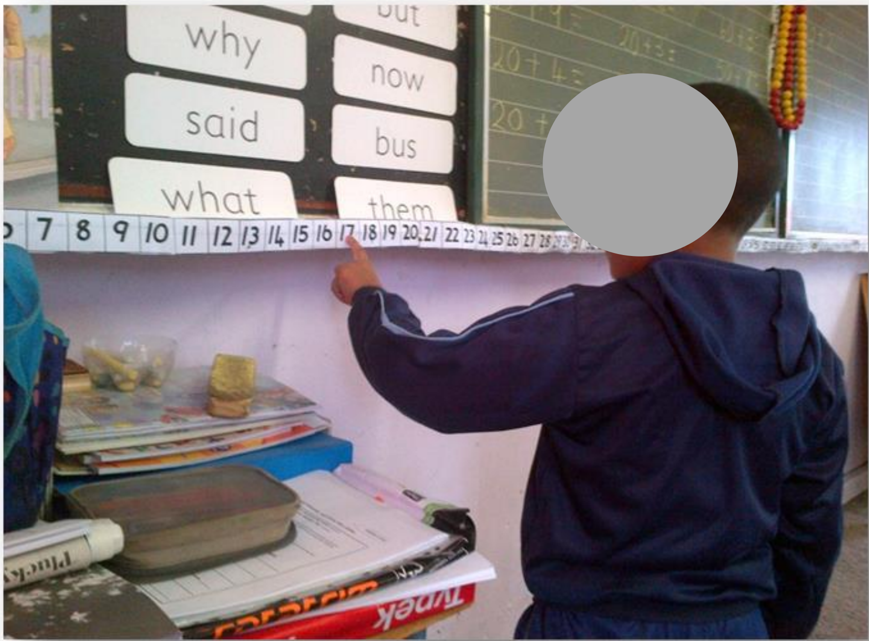



Figure 5.20 Learner uses a number line to double numbers

According to CAPS (2012:65) the use of number lines should be supported by concrete material such as counting beads. This is because a number line is considered to be an abstract concept and research shows that young learners learn through three steps, using concrete material (objects), semi-concrete (pictures and drawing) and then abstract (CAPS, 2012). Teachers should then provide experiences through which learners will be able to develop and build connections (Van de Walle et al., 2010:26). Concrete materials help learners understand that the last number said, represents the amount of the whole set, the numerosity (value) of the set. So when doubling, the learners would see 8 objects and count another eight objects, using the number line simultaneously with the string of beads, because resources assist learners to make abstract concepts concrete (Nishida, 2007:1).

The teacher wrote sums on the board and asked the learners to represent the sums with dienes blocks to show the number sentence and answer. 10 + 2 = 1 ten block and 2 loose dienes blocks. The work on the board was graded to 3 groups, bottom, middle and top. The teacher allocated one learner per sum to come to the front and show the sum using the dienes blocks. Using the dienes blocks is important: calculating using the break-down method is one of the requirements in Grade 2, as it makes calculating easier (CAPS, 2012:195). The break-down method refers to breaking a number into smaller portions to make calculating more manageable (CAPS, 2012, 195). Numbers can be broken into different parts. Learners learn to break up a number into parts that are manageable for them (CAPS, 2012). Therefore, before calculating, learners need to fully understand the place value concept. Figure 5.21 depicts one of the learners laying out a sum using dienes blocks.

Figure 5.21 A learner lays out a number sentence using dienes blocks

The teacher then took the bottom group to the mat (the owl group). The teacher used blue books to keep the rest of the learners constructively busy, explaining the blue book work to them. Blue books are rainbow work books that have been developed for learners in South Africa. Figure 5.22 is a picture of a learner's work on the mat breaking down the number 41.

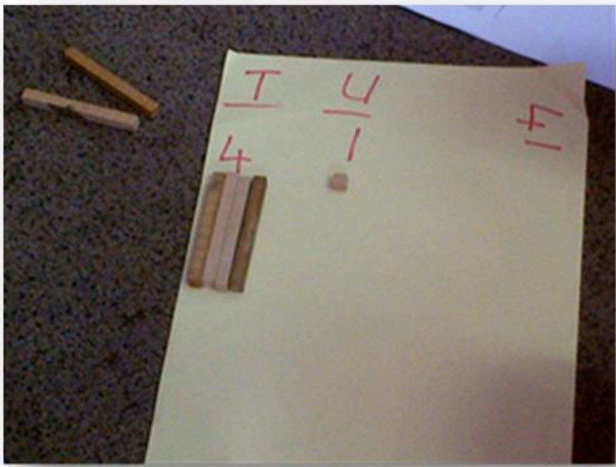



Figure 5.22 making numbers with dienes blocks

The teacher asked one learner on the mat to make the number 41 with the dienes blocks. The learner took one ten and four 1s and said that was 41. The teacher then wrote the number 41 on a big page and the learner immediately realised that there had to be 4 tens and 1 one (unit) (because of the order of the numbers). This shows that the teacher realised that it was important for learners to not only hear given numbers, but to also see them, using flashcards or writing down the numbers on the board. The teacher then wrote tens and units on the page and told the learners to place the tens under the tens and the units under the units. Thereafter, the learner had to draw a picture of the dienes blocks. The teacher then said 41 plus 22 and the learners packed out 2 tens and 2 ones and drew the number/dienes that make 22 next to those that make 41. Drews argues that the aim is to allow mental imaging, engagement and internalizing the resources so that learners can use the images even in absence of resources to solve future mathematical problems (Drews, 2007:20). The teacher then asked what the answer was. The teacher made learners aware of counting tens first and then adding the ones. The learners counted the tens first and added the ones correctly. The learners were then told to do the work in their blue books. Figure 5.23 show the learners using concrete and semi-concrete materials to represent numbers.

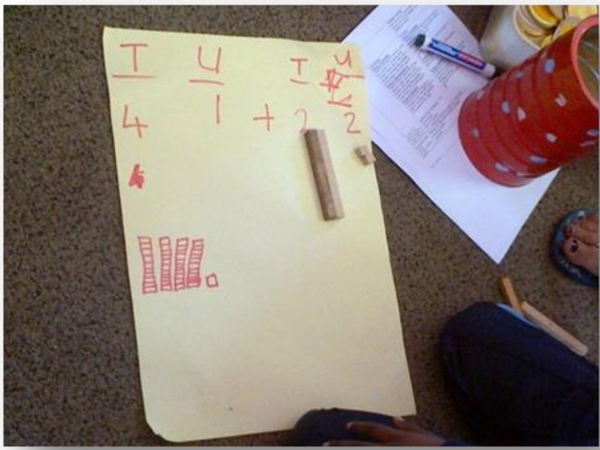


Figure 5.23 adding two-digit numbers using dienes blocks

The teacher took a second group onto the mat (16 learners). According to CAPS (2012:13), “small group focused lessons are most effective when the teacher takes a small group of learners (8 to 12) who have the same ability with her on the floor or at their tables”. Sixteen learners were too many and they should have been split into two groups to allow the teacher to give every learner on the mat the attention and space that they needed. This group was told that they would not use counters. The teacher wrote a number sentence 44 + 23 on the page and asked the learners what to do. She encouraged the learners to decompose the numbers into tens and ones (units). The teacher asked questions such as “What is 44?” – a somewhat ambiguous question to which one might expect all manner of answers from the learners. However, they seemed to know what was expected from them and answered, “4 tens and 4 ones”. The teacher then asked, “What is 4 tens?” and the learners answered “4”, which could have meant that it was the first 4 in the number 44. The teacher could have asked questions such as how many tens there were in the number 44? What number is that? And how many units? What number is that? How many tens and how many units make the number 44? The teacher could have underlined one digit at a time and asked what number it stands for. After the learners answered incorrectly that 4 tens was 4, the teacher then asked again what the number was and the learners answered 44 (forty-four). The teacher then explained that it was not a four but forty. Although the teacher felt that these learners did not need resources because they were in the top ability group, CAPS (2012) clearly advises us that the use of resources from Grade R to Grade3 is compulsory. One must also bear in mind that this lesson was observed at the beginning of the second term which means that concepts are being taught, and not revised. Resources should have been made available to the learners so that they could decide for themselves whether they wanted to use them or not. The learners then decomposed the number into tens and ones. Figure 5.24 shows a learner using the break down method to calculate 44+23.

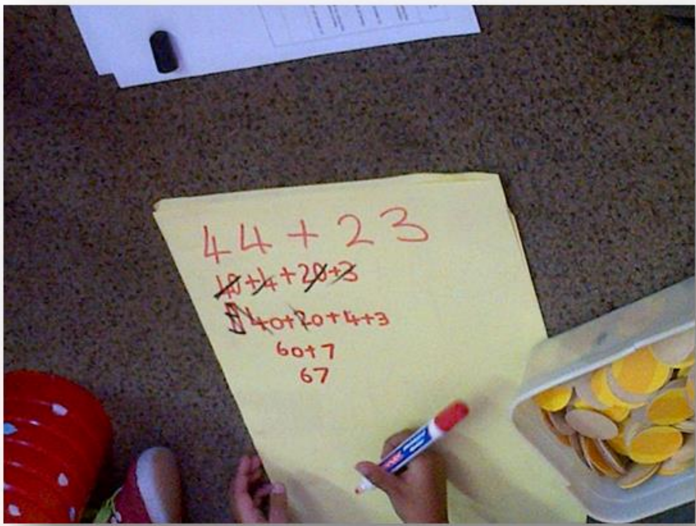



Figure 5.24 Learners use the break-down method to calculate with two-digit numbers

### 5.2.5 Lessons from Teacher 3B, school B (Grade 3)

The teacher started her lesson with a whole class activity, counting. Counting plays an important role in “enabling learners to develop number concept, mental mathematics, estimation, calculation skills and recognition of patterns” (CAPS, 2012:10). Brannon and Van de Walle (2001) concur that oral representation is a powerful, accurate and widespread tool for working with numbers. Marmasse et al. (2000) assert that individuals who have mastered oral numbers do not need to count from one up to that number, in order to make sense of numbers and do calculations. The teacher had a big number grid or chart in front and the learners had small ones in their books. The learners were instructed to count in 1s starting at number 6 using their number grids and were told to stop suddenly. Then they were instructed to count backwards in 1s from the number 45. The teacher then told the learners to count in 2’s starting at different numbers, such as 34, 28. The learners then counted in 3s starting at the number 3. They made a mistake by including the number 14. The teacher told them to stop and count again. The teacher told the learners if they were counting in tens backwards, they would be going upward and if they counted forwards, they would go down. She could have used that opportunity to ask the learners which way they were going when they counted backwards? Which way they were going when they counted forwards? CAPS (2012) requires teachers to ask questions to allow the learners to think critically and to help them use mathematical language.

The teacher presented a mental mathematics lesson with the whole class. She asked how many days there were in a week, month, year, and in two years. The teacher asked how many months there were in one and a half years and asked the learners to explain how they counted and arrived at their answers. The teacher asked how many minutes there were in one hour and in one and a half hours and asked the learners to explain how they arrived at their answers every time.

The teacher had flashcards containing numbers and a semi-concrete representation of the 100 and 10 dienes blocks. She asked how many blocks there were in the 100 dienes block. The learners answered “100”. Then she asked the learners to count as she placed the 100 block on the board. She placed three 100 blocks on the board and the learners counted to 300 in 100s. Then the teacher put the 10 blocks on the board and asked how many of these she would need to make 100. The learners answered 10, the teacher put ten 10 (long) blocks on the board and the learners counted in 10s and reached 100. The teacher took away 1 ten and asked the learners how many there were, the learners answered “90”. The learners then counted everything starting at 100. They counted the 3 100 blocks in hundreds and counted on in tens for the 9 ten blocks.100, 200, 300, 310, 320, up to 390. The teacher again made the learners aware of the fact that ten 10 blocks make 100. She said, *so ten 10 blocks are the same as 100 blocks.* Figure 5.25 shows the teacher’s hand-made semi-concrete dienes blocks and flashcards with numbers.

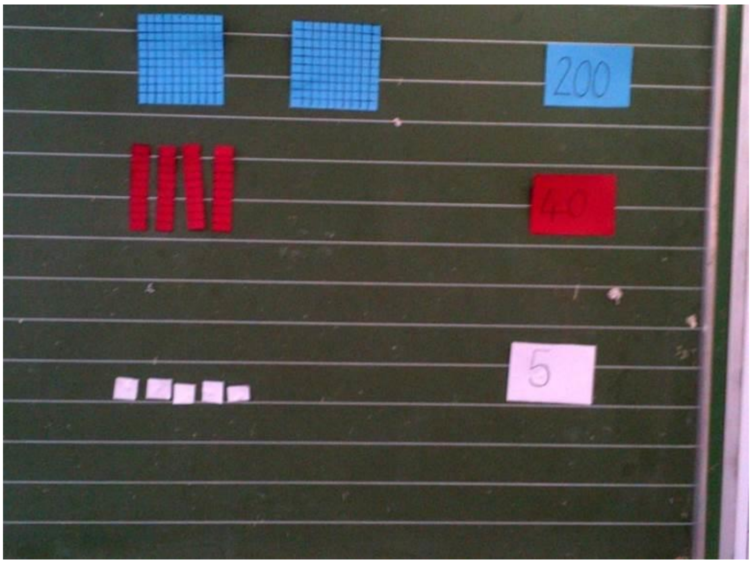



Figure 5.25 Semi-concrete dienes blocks

The teacher then introduced the units and put 5 loose blocks on the board. The learners counted the units in ones. The teacher took away one 100 block and left two 100 blocks, four 10 blocks and five unit blocks. She asked the learners “how many 100s?” “What number is that?” The learners answered “200”. The teacher put the card with number 200 next to the blocks representing 200, the card with number 40 next to the four tens and the card with 5 next to the five units as depicted in figure 5.24. The teacher then wrote a number on the board, 245, and underlined one digit at a time and asked the learners what the value of each digit was. “What is the number represented by the digit?” The learners answered correctly all the time. The teacher verbally gave learners addition of 10 number sentences for example 67+10 and the learners put up their hands to answer. The teacher then handed out worksheets for the learners to do at their tables. The teacher handed out 2 worksheets per learner and explained explicitly what needed to be done. She read and explained each question.

**Group activity (7 learners)**

The teacher called a group to the mat and instructed them to bring their pencils with them. Each learner was given a blank page. The teacher put some tens and units blocks on the mat and told the learners to take out a few. The teacher picked up 1 ten block and asked the learners how many 1 blocks there were in a ten block. The learners indicated that the answer was 10. The teacher then wrote a number on the board and asked the learners to make up the number with their base ten blocks on their pages. She then asked how many tens there were in that number as well as how many units. She then asked the learners to add 10 and asked the learners what they observed. “Which block must they add?” Learners answered 1 ten block. The teacher asked if the units stay the same or change. The learners answered that the units do not change. The teacher then handed out number sentence strips to make the number sentence with the blocks. The number sentences were all adding 10 (+10). According to CAPS (2012:98), by the end of Grade 3, learners should know what each digit represents in a number. Learners should be able to decompose three-digit numbers up to 999 into multiples of hundreds, tens and ones (units). They should be able identify and state the value of each digit. The teacher’s lesson was important, because she used appropriate resources, gave the learners a variety of opportunities to engage with the place value materials, concrete, semi-concrete as well as abstract materials, while covering all the concepts and skills stipulated by CAPS. Ojimba (2013:46) asserts that this process enables learners to move to the next stage of the learning process at their own pace, thereby fostering proper understanding of number concepts. Furthermore, Numbers Operations is a strong predictor of later fluency in calculation (Locuniak & Jordan, 2008:453). Basic mathematics and number concepts employed in Foundation Phase classrooms set the basis for learning more advanced mathematics concepts (Abramovitz, 2012). Figure 5.26 shows a picture of the learner’s work using concrete materials (dienes blocks) to make sense of abstract calculation, 16+10.


Figure 5.26 Calculating using dienes blocks

**Second group (12 learners)**

The teacher took a second group of learners to the mat for small group teaching. Each learner was given a different number sentence strip with the subtraction (-) sign or symbol. The teacher explained that 10 had to be taken away. The learners wrote and did the sums on a white page using the blocks and had to pass on the strips to the next learner when done writing and working out the sum. The group under discussion was clearly a more advanced group compared to the previous group because they spent less time on the mat and were dealing with a more advanced concept, namely subtracting. Although they were more advanced, the teacher understood the importance and benefit of allowing them to use resources. As a result, the teacher did not even have to explain in much detail because the resources were right in front of the learners to explore and investigate for themselves. Figure 5.27 depicts one of the learners' work after successful completion of the number sentence 29-10=? using the dienes blocks.

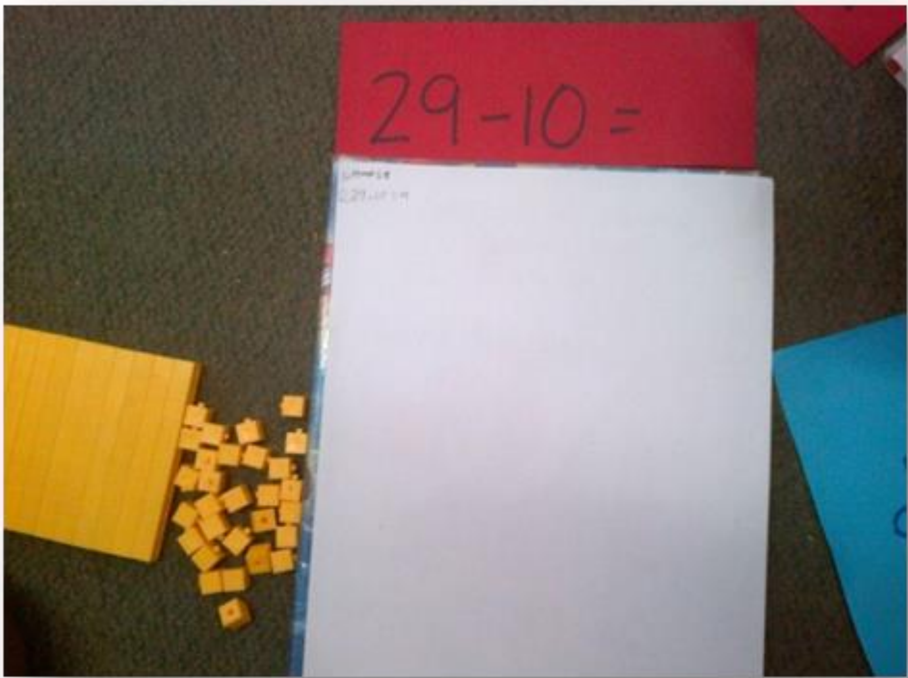



Figure 5.27 Subtraction with 2-digit numbers using the dienes blocks

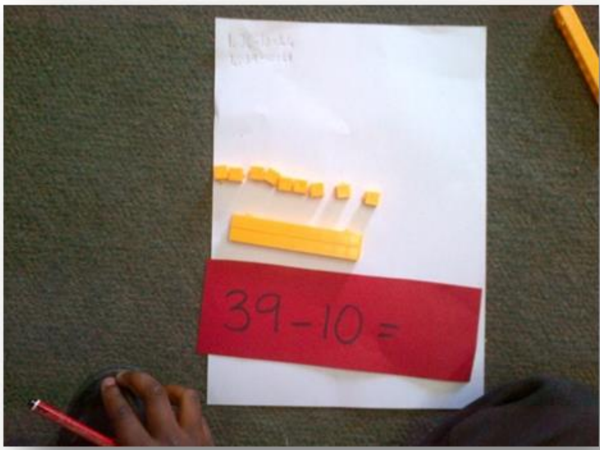



Figure 5.28 A learner subtracts using the dienes blocks

Learners were then given the following activity to complete at their tables, involving a semi-concrete worksheet (see figure 5.29). It contained the same content that was taught on the mat. The use of pictures in mathematics texts is an important educational tool for presenting or representing ideas to learners. Textbooks and workbooks such as the blue books (Department of Basic Education) are being used for visualisation to achieve clarity and focus (Yerushalmy, 2005:217). CAPS (2012:68) explains that learners must be given worksheets that are straightforward and familiar so that they can complete the activities independently as consolidation, and allow the teacher to teach a different small group on the mat. The teacher must ensure that all the learners understand them.

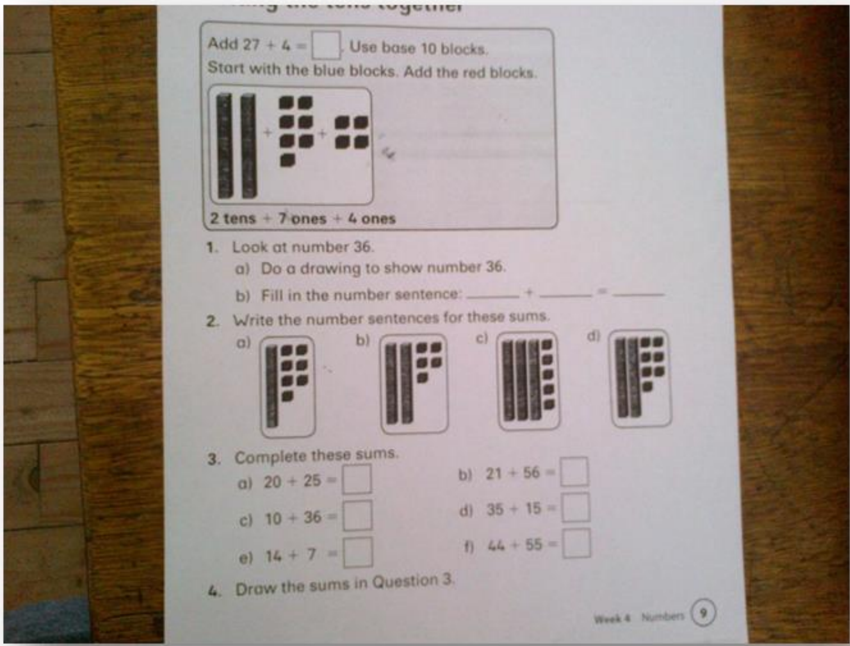



Figure 5.29 Semi-concrete worksheet for consolidation of lesson

## 5.3 FINDINGS BASED ON SEMI-STRUCTURED INTERVIEWS

According to Delamont (2012:364) “We interview in order to find out what we do not and cannot know otherwise”. Among the pertinent questions posed were the following: What is your highest qualification? How many years have you been a Foundation Phase teacher? Do you have all the mathematical resources stipulated in the CAPS document? What is the purpose of using resources when teaching Mathematics? These questions were important because one needs to know whether the teachers were trained to teach in the Foundation Phase and understood the purpose of teaching with resources in the phase.

### 5.3.1 Teachers’ perceptions of why resources are important

When asked what the purpose of resources in teaching number concepts was, teachers gave similar responses, namely that resources were important to promote understanding in the Foundation Phase. Teacher 2A replied:

> *"If I look at my children, resources is important especially for me because most of my learners whenever I teach a new concept, I have to go through those three stages where it is the concrete stage, the semi-concrete stage and then an activity because if they don't see or feel or look. Like when you are busy with hundreds, tens and units, you have to show them the hundreds cause they might not grasp it. You have to have that resource where it says hundreds, tens and units. So for me resources are important. I need resources but there are many other things like we doing eighths now, we doing sixths. Your first group grasps it immediately, they see oh teacher if you cut it into eight each part is called a eighth. But the other children I have to actually cut an orange or an apple so they actually see and they will still tell you that that 1 eighth is one apple."*

Teacher 1B answered:

> *"Definitely, like with studying also it works if you start with touch, feel, see, smell. So especially with those children that struggle, it's easier for them to take something and say right, so this is one and put it aside, pick up another one, if you put it together it's two. If you take one away it's like minus, so like resources are very important cause even with the top learners, they might know what going on but for them to touch and like with the flard cards and like sucker sticks. When explaining any concept, things like counters are amazing, things like sucker sticks, later on when you do flard cards it's amazing how these children need to see it in front of them. You can't just tell them 4+3. They need tactile at this stage."*

These answers and those by other teachers suggests that teachers know the value of mathematical resources and understand why they are important in teaching number concepts development. However, when probing deeper, it became clear that although they knew that using resources was an important component of teaching, they did not always use them when they should have. The Grade 3B teacher understood that for concepts to fully develop, the crucial stage of using resources is important. She explained that:

> *"Resources are important for the learners especially concrete material and concrete resources. I think that would really make it, it does make a difference coz you take them back to the basic, the foundation for them to grasp that concept from the beginning with um your, uhm, blocks and things for them to actually develop that concept. It does, it makes the difference. I think that would be an ideal environment, to work with those resources but we not working in an ideal environment and there needs to be work in the learners' books."*

The Grade 1B teacher said:

> *"That takes a lot of time which you don't always have"*

The Grade 2B teacher answered:

> *"I don't use them in every lesson, it's not practical. I find as much as I'd love to, it's just not practical with the time constraints."*

This kind of attitude has implications for the quality of education in South Africa, which is already last out of 62 countries in terms of learners' mathematical ability (Wallace, 2013). Spaull (2013:4) explains that when certain components of teaching are omitted, growing gaps result between what learners should know and what they do know. The Grade 2B teacher further explained that:

> *"It depends on the complexity of things that need to be done. If I need to, I do. I don't use the same resources for all the learners. I find that the top group doesn't need resources all the time, but sometimes they do."*

The importance and benefits of using resources were well understood by the teachers, however, putting their understanding into practice was a challenge. The teachers admitted that they mostly used resources with learners when they were struggling to grasp a certain concept. The problem with this type of teaching is that the learners who appear to understand tend to be deprived of important stages of learning mathematics. This is because there are learners who are just good at listening, following instructions and copying procedures exactly as they are shown and told. Following procedures correctly, though, does not necessarily mean that they understand the concept.

It seems that the workload of the teachers was affecting the quality of their teaching (Mbugua et al., 2012:87). It seemed that teachers were more concerned about covering the curriculum than providing quality teaching. The Grade 3B teacher explained the reason:

> *"I find sometimes I brush through things simply cause I have to get through the curriculum and when CAs (Curriculum Advisors) come, you have to have covered everything. So at the same time were robbing learners but were being pushed. It's too much work in the Foundation Phase and we need more time but the children can't be in school the entire day it affects them."*

### 5.3.2 Challenges teachers face in teaching mathematics

Several challenges were identified by the teachers as preventing them from teaching effectively and using resources optimally or resourcefully. The teachers complained about (a) time constraints (b) overcrowded classes (a teacher-learner ratio that hinders individual attention) (c) language barriers and (d) disciplinary issues which became apparent from the data presented below.

#### 5.3.2.1 Time

The teachers indicated that there was generally not enough time to cover everything stipulated by CAPS, or to go through all the necessary steps to ensure understanding. When asked what might be the cause of poor results in our country, the Grade 1B teacher replied:

> *"I would think. Well I would have to take some experience from us as a school but I would think there's so much emphasis on marks, marks, marks and certain things need to be done in certain number of weeks and assessment 1 must be done after 4 weeks. Like I said, a lesson never goes according to plan. So a concept might take me 2 weeks instead of a week, but because assessments need to be done in 4 weeks, I'm now rushing and some of the children don't understand. The weaker children are even more lost than what they usually are because I think it comes down to a lot of pressure, that pressure of marks. So even us a teachers, without even realising it, because we get pressure from higher authority, we start putting the pressure on the children, especially with doing work. We say come guys, be quicker where they maybe just need that extra time to understand a concept."*

It was clear from the response of teacher 1B that quantity becomes more important than quality, because quantity is immediately measurable. Mbugua et al. (2012: 87) found that some teachers use the "lecture method" to teach as this is less time consuming in terms of content coverage. Evidence in the learners' books can be used to measure the amount of work taught by the teacher. If more quality is invested in the learners' understanding with the inclusion of all necessary components of teaching number concepts, then it would take a longer to produce the same amount of work in the learners' books. However, lecture methods on their own are not effective because they do not encourage learners to actively participate in the process of learning (Mbugua et al., 2012:87).

The Grade 3B teacher also stated that time militates against teaching in (small) groups. She conceded that:

> *"It's very difficult to always teach in groups. I think in reality dealing with the number of learners that I am faced with, it's not possible to do it all the time. As well as the amount of work that needs to be covered per term, it doesn't give you the opportunity to deal with grouping, uh, group work all the times."*

Teacher 3B also complained about having a large class, so one might argue that that is all the more reason why she should do group teaching, there being too many learners to teach effectively at the same time. She further explained:

> *"I find sometimes I brush through things simply cause I have to get through the curriculum and when CAs come, you have to have covered everything. So at the same time were robbing learners but were being pushed. It's too much work in the Foundation Phase and we need more time but the children can't be in school the entire day it affects them."*

In order to explain why they were not teaching the way that they are expected to, even though they knew what was best, the teachers insisted that there was too little time. The Grade 2B teacher stated:

> *When they get to Grade 2 we start doing things that are geared towards the systemic and ANA. I look at the previous ANA test and I make sure when teach I emphasise things that I know will appear. You sort of get to know how the structure of the paper is so you try to teach using that structure.*

The Grade 2B teacher admitted that she focused her teaching so that the children could pass the ANA and the systemic assessments which means that she taught by practising question papers. Although this is disconcerting, one cannot blame her. Her school admits that although their learners are generally weak, they somehow do pass the systemic and ANA assessments.

#### 5.3.2.2 Language barrier in learning number concepts

The language of learning and teaching (LOLT) presents challenges for some teachers as they are expected to teach in a language that most of the learners do not understand. The Grade 1B teacher seemed to think that more than anything else, language was her biggest obstacle in class. In teacher 1A's class of 38 learners, 18 were isiXhosa, 5 Afrikaans and 15 English speaking. In teacher 1B's class of 33 learners, 20 were isiXhosa, 11 were English, 1 was Sepedi and 1 was Setswana. Teacher 2A had 39 learners, of whom 18 were isiXhosa, and the rest were English; in Grade 2B there were 42 learners, of whom 31 were isiXhosa and the rest English speaking. In Grade 3B the teacher had 41 learners, 30 isiXhosa and the rest English speaking. The teachers said that by the time the learners got to grade 3, language would not be so much of a problem unless they had arrived from other schools. The grade 1 teachers had the greatest challenge when it came to language. They teach learners from isiXhosa- or Afrikaans-speaking homes who had often not been exposed to English. The Grade 1A teacher said:

> *"I think more than, before maths I would say just in general, the language barrier. So in order for me to explain a concept, I first need to break down what I'm saying into simpler form. Then you also have those learners where some of them are just completely lost with the numbers like some of them write it the wrong way or can't do it in the correct order. But I would say that the main problem would be the language barrier because some of them don't understand necessarily what I'm doing on the mat or whatever."*

Teachers explained that although the language of learning was not understood by all the learners, they did not teach in the learners' languages either, because they did not know how to or because they just felt it was not the language of teaching. The Grade 2B teacher stated that:

> *"Our school's Lolt (language of learning and teaching) is English so I don't teach in the learners home languages unless there's a child who comes from an Afrikaans school, I probably would but when parents enroll their children we tell them that is your child's home language but our school is an English medium school so parents do understand where that is concerned."*

The Grade 3B teacher said:

> *"I think my most, the difficult one out of all, is the language barrier because they don't get the concepts, they can't grasp the concepts, uh, uh, as opposed to home language it's different but I think with mathematics it's more difficult."*

Proficiency in the LOLT is a prerequisite for understanding and making sense of the language of mathematics (Siyepu & Ralarala, 2014:327). That teachers were not teaching in learners' home languages made teaching and learning mathematics more challenging.

#### 5.3.2.3 Overcrowded classrooms

The Grade 2B teacher explained that: *"Sometimes I find it difficult. I've got a very small classroom, but a very large number and a lot of learners who are actually in the bottom group. It makes it difficult. I try to but it's difficult."* Mbugua et al. (2012:90) suggests that this shows that even though South Africa is a democratic country, education is still not equal. Learners are not given the same quality of education throughout the country. The number of learners in teachers' classrooms influences the teachers' ability to be resourceful (Adler, 2000). Teachers need a certain amount of space to teach a certain number of learners effectively.

#### 5.3.2.4 Insufficient resources

Grade 1B teacher:

> *"Yes I have most of the resources but I would love to have more resources. I have the counters, the sticks and other things, but you can never have enough resources. And also I don't have 33 of each resource. So its groups of 11 but sometimes I only have 8 of a particular resource then I will need an extra 3. So the resources are not always enough for the big groups I have."*

Grade 1A teacher*:*

> *"Very little uhm, resources like uhm manipulatives and stuff from the actual maths kit and uhm, learners understanding of the concepts."*

Although some the teachers were not satisfied with the amount and types of resources they had, no visible shortages were noted during the classroom observations. Teacher 1B went as far as to say she would like 33 of each resource. This is not necessary because in the Foundation Phase learners are taught in groups, so teachers need only 8 to 12 of each resource to use on the mat with the learners.

#### 5.3.2.5 The use of lesson plans

The teachers all used different lesson plan formats. This showed that they did not engage in planning jointly as a phase. Furthermore, the lesson plans were not always followed, due to several common factors such as interruptions, time constraints and lessons not unfolding as anticipated. Ollerton (2004:13) maintains that the teaching of number concepts is guided by the learners and not by the prescribed curriculum or rigid planning. This means that the teacher's planning should reflect the actual progress made by learners, regardless of what the curriculum stipulates. The Grade 3B teachers explained that:

> *"it's interference from the SMT [school management team] not just the SMT but other programs at the school. Fundraising included which I find ridiculous and too much. So it sort of interferes with the lesson plan. Sometimes it's necessary to go back when the children don't understand."*

The Grade 1B teacher answered:

> *"You will always expect that 1 child that needs extra help with, like repetition of a concept or there's children that fight cause they don't wanna share the counters or it can be many, many things. Sometimes I'll be on the mat with the children and maybe I didn't think of maybe the child asking this one particular question or needing me to explain a part of the concept and that would take like a extra 15 minutes from what I had planned on the lesson plan. So actually I don't think it actually ever goes according to plan actually."*

This suggests that the Grade 1B teachers' planning is not really effective if it "never goes as planned". When planning, the teacher should know where the learners are more or less and what the teacher would like to achieve at the end of each lesson. This may not always go as planned but stating that: "I don't think it actually ever goes according to plan actually" means that the teacher needs to reflect on her planning and her teaching. This could be that she needs to re-group the learners and teach work that is at their level. "Effective mathematics teaching entails understanding what learners know, what they need to learn and then challenging and supporting them to learn it well" (NCTM, 2000:16).

The Grade 1A teacher concurs:

> *"Sometimes maybe a learner is uhm maybe we doing number 12 but there's one learner or two learners in a group that actually cant concept the number 12 or can't even do sums or even count on to twelve and then I've gotta go back to get them to that understanding before I can move on."*

There are many factors that contribute to lessons not going according to plan or not taking place at all ranging from school to school. This means that lessons have to be postponed but not cancelled because all the content needs to be covered . It also means that if a lesson or more is lost then the work has to be covered in a shorter space of time. The Grade 2A teacher stated that:

> *"because uh, when we prep, we prep to do a certain lesson for that particular day or for the week. But sometimes you find you prep something for Tuesday but you didn't really reach your goal in Monday's lesson so you go back. So sometimes you got to go back to that lesson. Sometimes you prep for the whole week and find that on Wednesday I'm still doing Monday and Tuesday's prep." Although one would argue that contact time should be protected and respected at all times, the reality is that it is not. Teachers are expected to be flexible and go in whichever direction the school demands, but then sort out the repercussions on their own. WCED clearly states that contact time spent on other activities should be replaced by extending the day and dismissing the learners later.*

A lesson plan is a central aspect of a teacher's effectiveness in designing and implementing teaching that promotes learning (Centre for Excellence in Teaching, 1999:29). It seems that although the teachers plan their lessons, adhering to their plans is not always possible, owing to factors ranging from learners' inability to understand as promptly as the teachers expected them to, to administration duties and other interruptions from the school.

## 5.4 The importance of resources when teaching number concepts

Mathematical resources are visual tools that help learners understand what is being taught or asked (Bornman & Rose, 2010:82). This section discusses observations made as well as the responses of teachers when they were asked about the importance of resources when teaching number concepts.

All the grades observed had rectangular mats in front of their classrooms where mat work took place. Mat work is what CAPS (2012:13) refers to as "small group focus teaching" with a group of 8 to 12 learners at a time. I observed the teachers using resources to teach number concepts. Some teachers used resources such as number wheels and number houses they had made, while others used resources such as dienes blocks and flard cards provided by the school. Teachers generally understood the importance of using resources to teach number concepts, but also admitted that they did not always do what was required of them when teaching number concepts. Not having access to resources all of the time makes understanding harder for learners: in order to be able to compute using the four basic operations, they must first have established fundamental concepts including more, less, many, one-to-one correspondence with real objects, the concept of sets and basic number sense (Abramovitz, 2012). Mathematical tools should be used to introduce, practise, or even remediate a mathematics concept (Boggan et al., 2010:2). It is important for learners to see mathematics and the calculations that they perform as part of their daily life.

Teacher 1A explained that:

> *"Purpose of resources in teaching mathematics is using them to manipulate or, using them to manipulate, to help learners to count, to do different concepts in*

> *mathematics." She continued: "I give my learners that are struggling in mathematics more hands on things to do, to work with more resources in the classroom, manipulatives. So I basically see what they're struggling in and try and make even work cards and work with them so that they're working on their level not on the learners who're above their level." This teacher only used resources when the learners struggle to grasp concepts.*

Teacher 2A pointed out the following:

> *"If I look at my children, resources is important especially for me because most of my learners whenever I teach a new concept, I have to go through those three stages where it is the concrete stage, the semi-concrete stage and then an activity because if they don't see or feel or look." This teacher also admitted that she did not always use resources.*

The Grade 2B teacher responded:

> *"I try to use resources during interval, I try to engage kids in those resources as and when they feel. I don't use them in every lesson, it's not practical. I find as much as I'd love to, it's just not practical with the time constraints. It depends on the complexity of things that need to be done. If I need to, I do. I don't use the same resources for all the learners. I find that the top group doesn't need resources all the time but sometimes they do."*

The Grade 1B teacher responded,

> *"That takes a lot of time which you don't always have but sometimes you make the time. As a teacher you make the time. Like right now what they're struggling with is the plus and minus of bigger numbers. Now obviously, the weaker children would use their fingers but now obviously we working with bigger numbers bigger than ten. So they'll do 6+5 and run out of fingers and automatically their answer would be 10. So with the weaker learners they need a lot of one on one and like I say with the resources, they must touch, they must construct something and tear it apart. It's a lot of one on one, having to tell them what to do."*

Resources are important, and teachers appeared to be compromising when it comes to making use of them. As a result, numbers of learners were not as proficient in mathematics as they should have been. This is problematic for the learners as well as for their next teacher. There was not one teacher in this study who said that they were using resources in the way in which they should have been. All the teachers described perennial problems they experienced with using resources optimally in teaching number concepts. This means that year after year, teachers are likely to continue to do the same because they believe that there is not enough time and that it is therefore not practical to use resources for teaching number concepts to the extent stipulated in the curriculum.

## 5.5 Teachers' perceptions of why number concepts are important

Teachers indicated that they viewed number operations and relationships as the most important content area. When asked why, teachers expressed the same view, namely that number concepts were the basis of all other mathematical concepts. Teacher 1B responded as follows:

> *"In order for you to understand the patterns and the shape and measurement you need to understand you basics which is numbers operations. Cause some of them are still struggling with the counting. So obviously if you doing patterns, you doing counting in twos now you need to fill in the missing numbers. You need to know how to count first before you can do such patterns."*

The Grade 2B teacher admitted,

> *"To be honest, I find myself most of the day doing number operations almost the entire session. Sometime it goes to the second session. Because I know there's a problem there and it would be unfair just to go through things and leave some things that I know are more important and the results."*

The Grade 1A teacher confirmed:

> *Number operations is the biggest concept. Yah I concentrate more on it because it the biggest area and also, whatever they learn in numbers operations and relationships they can use in the other concepts.*

The Grade 2A teacher said that she currently considers reading as the most important and explained:

> *"because I'm thinking these children need to be able to read a question paper in Grade 3."*

The Grade 3B teacher explained:

> *"I would say most of the content is covered. But I would say number operations is dealt with daily. If I'm doing number operations, with that goes my data handling or my space and shape or uh you know which ever other or the number patterns but on those days, included in those days, I'm doing number operation."*

It was clear that the teachers naturally focused more on number operations and relationships without being aware that this is precisely what is stipulated in the CAPS document. They tried to justify why they did so but they could just as well have said that it was what the curriculum requires.

## 5.6 Helping learners who struggle with number concepts

The teachers' responses to how they helped learners who struggled with number concepts indicated that these learners did not seem to be able to understand even when intervention was provided. This frustrated the teachers as they did not know what else to do in terms of supporting the learners and teaching them what they should learn. The Grade 2B teacher stated:

> *I need resources but there are many other things like we doing eighths now, we doing sixths. Your first group grasps it immediately, they see oh teacher if you cut it into eight each part is called a eighth. But the other children I have to actually cut an orange of an apple so they actually see and they will still tell you that that 1 eighth is one apple.*

The Grade 1B teacher said that she gives her learners who struggle with mathematics more hands-on things to do, she allows them to work with more resources in the classroom like manipulatives.

> *"So I basically see what they're struggling in and try and make even work cards and work with them so that they're working on their level not on the learners who're above their level."*

The Grade 1A teacher thought the problem was that a lot of learners were either not getting support at home or hadn't even had Grade R support, so they were coming to school not even knowing certain numbers and not even able to count in Grade 1. She indicated that certain concepts, like that of pattern, were not actually there, so you hadto keep on going back which meant that the whole class could be held back.

> *"So I think what happens is when it comes to assessment time we haven't covered everything that's in the assessment which creates a problem."*

The Grade 2B teacher answered,

> *"I try to but they just never get to understand. I've got a child who still doesn't know how to add 5+5. I was actually frustrated."*

The teachers' responses to helping learners who struggle with number concepts showed that the teachers were not getting through to the learners. Teachers admitted to using resources more often with struggling learners. They seemed to use resources more as an intervention tool. However, it seemed that whatever intervention they were doing was not effective. Learners still did not understand the number concepts taught, which means that the teachers ought to be reflecting on their teaching methods. Perhaps using resources in the first place, and using them in the right way, might address such problems. Mtetwa (2005:255) asserts that improvement in the quality of teaching is the responsibility of teachers. Van de Walle et al. (2010:23) concur that being able to critically reflect on oneself for areas that need development or to reflect successes and challenges is crucial for growth and development. They further argue that the best teachers try to improve their practice through reading the latest articles, newest books, attending conferences and reading conference proceedings.

## 5.7 SUMMARY

This chapter presented and discussed the results from the data collected through the analysis of documents, lesson observation and semi-structured interviews. It offered an overview of how teachers plan for mathematics lessons, how they use resources to teach number concepts in the classroom, and it provided insight into their thoughts and experiences. What stood out in this chapter were the challenges that prevented teachers from using resources, their use of resources for struggling learners, and the tendency of the system to favour quantitative over qualitative teaching. The next chapter discusses the conclusions, recommendations and implications of the study.

# CHAPTER 6
# SUMMARY OF RESULTS, RECOMMENDATIONS AND CONCLUSION

## 6.1 INTRODUCTION

The aim of this research was to investigate Foundation Phase teachers' use of different mathematical resources to teach number concepts in one district of the Western Cape in South Africa. Of particular interest was the question of how these resources were being used to promote understanding and support the learning of number concepts. The study looked at the use of counters, bead strings, abacuses, base ten blocks, number lines, number charts and number tracks, as recommended in the CAPS document.

This chapter summarises and reflects on the results presented in Chapter Five. These derive from the various data collection instruments used: documents, lesson plans, observations and interviews. The discussion also distinguishes among the various types of resource observed in the mathematics classroom: material objects, humans, time, and language.

The chapter goes on to consider the limitations of the research and its significance, suggests avenues for further research, makes recommendations and provides a conclusion.

## 6.2 RELATING THE RESULTS TO THE RESEARCH QUESTION

The research question of the study was:
How are mathematical resources used to teach number concepts in the Foundation Phase?

### 6.2.1 Results from the lessons observed

During the observations it was found that the teachers were aware of what the CAPS document stipulated about mathematics lessons in the Foundation Phase. All their lessons started with a whole class activity before the teacher engaged with a small group on the mat, leaving the rest of the learners working independently at their tables. The mat work was identified as Stage 1 of the stages within Vygotsky's ZPD (Polly, 2012:81). This is the stage in which the more knowledgeable other assists the learner by scaffolding the learning process. The teachers engaged with the learners through asking questions and using various resources such as number lines, counters and dienes blocks. The teachers supported the learners through modeling, guiding and discussion in order to get to the desired learning outcomes.

Stage 2 in Vygotsky's ZPD is called self-assisted learning (Dunphy and Dunphy, 2003: 40-50). This is when the learner is able to perform tasks independently while trying to make sense of what they are doing. This does not mean that the performance is fully developed or internalised (Dunphy & Dunphy, 2003: 49-50). It merely means that the control and direction of the performance has been passed on to the learners (that is, a progression from other-regulation to self-regulation). This stage of the ZPD was visible at the learners' tables after the lessons on the mat. Learners were then given activities to complete independently at their tables. Learners were expected to do the activities on their own but could still ask for help if necessary. Teachers differentiated the learning activities to suit the levels at which the learners were competent. The exception was when the DoBE blue books were used, because these books are all the same and do not differentiate among learning activities.

Stage 3 of the ZPD refers to when performance is developed and automatized (Dunphy and Dunphy, 2003: 40-50). At this stage the learner is fully able to perform on his/her own and has advanced from the ZPD into the developmental stage for the task. The task is now achievable without intervention or assistance from the more knowledgeable other. Stage 3 of the ZPD took place right at the beginning of the lessons when the teachers allocated activities to the class before taking a small group onto the mat. Learners were allocated activities to complete on their own. These were activities relating to concepts taught and understood already.

This stage was more visible in some classes than others. In the Grade 1A and Grade 3B classes, learners constantly came to the mat where the teacher was busy with a small group to ask for assistance with the activities assigned them. In the rest of the classes the teachers could go through the whole lesson without interruptions from the other learners.

### 6.2.2 Resources used as intervention

Teachers revealed that it was not always possible to teach in the way CAPS required. CAPS (2012) stipulates that number concepts should be taught using specific resources in the Foundation Phase. Teachers stated that they used resources to assist learners who were struggling with mathematics, arguing that they were the ones in most need of resources.

During interviews, teachers revealed that they faced many challenges which had an impact on the effectiveness of their mathematics teaching. They felt that there was too much work to cover in the curriculum and this discouraged them. They did not know how to fit everything they had to teach into the school day and thus left out important activities so that there was evidence of work for WCED officials to see when they visited the schools. This resulted in learners not being where they were supposed to be academically. According to Vygotsky (1978), it is in the ZPD stage 1 that teaching and intervention occur in a variety of forms, including modeling, coaching and other methods of scaffolding (Polly, 2012:81). Proper teaching methods and the correct resources should be used in order for learners to move to the next stage.

Learners came from previous grades without the knowledge that they should have had. This made it difficult for the teachers to fully focus on the current grade's work. However, Vygotsky's sociocultural theory on learning states that the construction of knowledge depends on the experiences of each individual (Alexandru, 2012:19). Knowledge is not a replacement of pre-existing structures, but rather a result of building upon prior knowledge. Thus, knowledge is a "subjective and individual process, which verifies cognitive, affective, behavioural schemes in relation to others, and also to the social environment" (Alexandru, 2012:19). All children come from a pre-school background with a wide range of individual differences in their early number knowledge (Ramani & Siegler, 2014:2). It is no wonder that teachers felt frustrated and did not know how to help learners get to the level at which they were supposed to be. This was because their starting point was not where the learners were, or did not proceed from what the learners already knew. If this theory is correct, then this means that one can teach as much as one likes, but still not be fully understood. Playing and other informal activities in an environment where adults provide children with new information, support their skill development, and extend their conceptual understanding is important (Ramani & Siegler, 2014:2). One can understand why the learners who struggled with mathematics did not respond satisfactorily to the interventions provided by their teachers. The teachers tried to help learners who were struggling by using resources, but the fact is they were still teaching them content that the learners were not yet ready to learn.

Learners who seemed to understand what was being taught were then given more semi-concrete/abstract work. Teachers stated that there were reasons why they did not always teach learners at the level at which they were at. They pointed out that the assessments from the Department of Education did not cater for where the learners were at: learners were all given the same assessments and the school was judged on the basis of these assessments. Although the department always includes lower order questions to accommodate weaker learners, the majority of the paper is normally that specific Grade's content. If learners were taught at their own level and where they were at, they would do badly in these assessments. The teachers were compromising on quality and on teaching for understanding. Teaching for understanding would have meant spending more time in stage 1 of the ZPD and providing different ways to scaffold and mediate the learning process. It appears that teachers were afraid that when the department measured the learners' performance, they would not look at where the learners were at or what they knew before coming to the Grade, but rather at what the learners should know when they exited the Grade. The department's question is: are the learners at the level at which they are supposed to be? That is their concern. If the learners score 50% then the department is happy. If the whole grade scores 50% then that is a 100% pass and the department will even reward the school for good teaching.

### 6.2.3 Resources used when the need arises

When learners are encountering a new concept or when they have not yet mastered a concept or have little understanding thereof, they are still at stage 1 of the ZPD where learning should be supported and guided by the more knowledgeable other (Dunphy & Dunphy, 2003: 40-50).

Teachers tended only to resort to resources when they saw that the learners did not understand a concept. This is not how teaching should be done in the Foundation Phase. The Foundation Phase is where a base is laid. It is also where learners know very little about the abstract content being taught. The more knowledgeable other should provide opportunities for learners to learn mathematics by providing the necessary support and tools and using the ZPD to scaffold the process of learning (Vygotsky, 1978). This is where teachers should attempt to bring the abstract to the concrete where learners will be able to make sense of it. The primary purpose of resources is to assist children to make abstract concepts concrete (Nishida, 2007:1).

As much as the teachers understood the value of using resources, they all expressed the same concern, time. Time is the most valuable resource in a mathematics classroom (Johnson, 2008). The most important aspect of time for teachers should be the amount of it that learners spend actively engaged in the learning process (Johnson, 2008). The view was expressed that the teaching time allocated to mathematics was not enough to cover all the content that needs to be covered in the manner in which it should be, if quality teaching and teaching for understanding were to be regarded as the main priority. If teachers jump to stage 2 of the ZPD when the learners still need to be at Stage 1, just because of time, it is almost certain that this will be the start of the teachers' and the learners' problems. It is no wonder that some learners get to the next grade without the knowledge that they should have, and the cycle only continues as the next teacher does the same, creating widening gaps.

Teachers expressed concern about having to record a certain number of activities in the learners' work books for when the curriculum advisors came. They had to cover certain content in a certain period of time. Teachers rushed through the work and often left out important steps.

There was an issue of time management. Teaching time was wasted due to interruptions that were beyond the teachers' control, such as assemblies and feeding. Johnson (2008) agrees that "time is the resource that we often pay the least attention to and end up abusing (wasting) more than any other". School A was a catholic school and the teachers complained that teaching time was often interrupted by mass (worship) at church. Teachers had to collect monies such as casual wear money, outing monies and had to check the learners' school fees. They had to attend to parents who came to their classrooms as there were no security guards to stop the parents from doing so. Measures should be taken to eliminate the waste of time on duties other than teaching.

### 6.2.4 Resources used to support written activities

It was clear from the lessons observed that resources were used to support written activities. It was observed that all the work done on the mat was a practical version of the work that the learners were expected to do at their tables. Or, to put it the other way round, written activities were all based on the work that the learners did on the mat. The learners were consistently moved from stage 1 (assisted by the more knowledgeable other) of the ZPD to stage 2 (self-assisted). The learners first did the activities with the teacher on the mat and then were given a chance to do the activities on their own. When learners showed signs of not understanding by doing the work incorrectly, teachers assisted them until they could do the activities on their own.

Learners in Grade 1A were instructed to use the number lines in their books to hop from 2 to 6 after the teacher explained and demonstrated how to hop. The teacher then looked around and saw that some of the learners had made more hops than asked. Some learners grasped the concept and others did not. Realising this, the teacher then told the learners to count the hops that were made on the board and then count their hops to see if they had made the correct number of hops. The teacher tried to help the learners who had more hops by counting and demonstrating on the big number line on the board. The teacher gave the learners more problems to solve using the number line so that they could master using the number line. They were then asked to complete one more problem on their own. This did not mean that the learners had reached stage 2 of the ZPD, although that was what the teacher wanted. One lesson for the concept of number lines was not enough. It was almost certain that if the teacher had given the same learners more of the same type of sums to do that same day or even the following day, they would not have been able to complete them without her assistance.

The teachers observed had access to the required mathematics teaching resources described in CAPS. Each classroom observed had a number chart, number lines, number tracks, strings of beads, and others. At school B, the teachers had their own learner teacher support material (LTSM) kit which consisted of all the required materials recommended by CAPS. School A had 1 kit to share among the whole school. At school A teachers did not use the LTSM kit because it was an effort to go fetch the resources they needed from the learner support teacher responsible for them, and they did not even know what it contained. They said that they would like to have a box for their own class. Teachers at both schools used the number line but did not use it with the concrete bead string as CAPS recommends. Learners were not given enough time to engage and explore with the resources because the resources were kept in closed boxes. These materials should not be in the boxes in which they originally came. They should be place in the mathematics corner for anyone who comes into the class to see so that the learners can use them. When learners went back to their tables to work independently, there were no resources available for them to use. If and when they used resources it was only on the mat with the teacher. At their tables, they only engaged in written work. This was because they had already practised the work on the mat with the teacher and the teacher probably saw no need for resources. However, if learners need to assist themselves as stage 2 of the ZPD suggests, the required resources should be available for them to do so.

### 6.2.5 Resources used as calculation tools

It was observed during lessons that resources were used to complete number sentences. Teachers used resources to help the learners get to the answers. Learners were shown how to use number lines as a calculation tool for addition and subtraction. CAPS (2012) clearly indicates that a number line is an abstract resource and should be used together with the bead string. This is to ensure that the learners understand the concept and make connections between the numbers on the number line and the amount of objects on the bead string. Using the bead string helps to avoid meaningless or rote learning because learners might be able to make the necessary or expected jumps from number to number and reach the correct answer by merely repeating what they were shown. Teachers then assume that learners understand and move them to the next level of the ZPD, stage 2 where the learners are able to carry out tasks on their own. This creates gaps that cause bigger problems in the following grades.

### 6.2.6 Language as a resource in the mathematics lessons

Vygotsky believed that in order for learning to take place, understanding the meaning of words is crucial. Language should serve as a tool mediating between the learner and what needs to be learnt. “Meaning cannot be separated from words and words without meaning is an empty sound and no longer part of human speech” (Vygotsky, 1986:5-6). The majority of learners in school B were isiXhosa-speaking learners. In Teacher 1A’s class there were 33 learners, of whom 20 were isiXhosa, 11 were English, 1 was Sepedi and 1 was Setswana. In all of the participant teachers’ classes, learners were taught in English despite the fact that their mother tongue was not English. Most of the teachers were able to speak English and Afrikaans, but not the African languages. This made learning a challenge, especially in the grade 1 classes, because most of the isiXhosa learners were being taught in English for the first time. By the time they advance to higher grades, they would be able to communicate in English, but by then they would have missed out on the basis of mathematics taught from Grade 1. Teachers said that it became an even bigger challenge when learners came from isiXhosa- or Afrikaans-medium schools and only started at an English school in Grade 3. The content to be covered in Grade 3 is much greater than in previous grades and communication lines are effectively closed.

## 6.3 SIGNIFICANCE OF THE STUDY

The poor performance of South African learners in mathematics is a major concern. There are many factors that may be contributing to this. One certain fact from the ANA results is that the problem does not start in the higher grades, it starts in the Foundation Phase. Because of this, learners' performance actually deteriorates as they progress from lower grades to higher grades. This study was part of a quest to explore the mathematics results of a particular school by investigating how resources were used to develop learners' understanding of number concepts. It is believed that mathematics can be best taught if a sound base is laid early on in the Foundation Phase. The chances of success in mathematics if mathematics resources are used properly is much higher. The purpose of this study was therefore to explore how Foundation Phase teachers use mathematical resources to teach number concepts.

Knowing how teachers use resources in their classrooms may be useful in identifying gaps between how learners should be taught and how they are actually taught. The results of this study may also assist in identifying one of the reasons for why learners do poorly in number concepts. Understanding the challenges that teachers face in using resources may help school management teams come up with possible solutions so that resources can be used properly and to their maximum potential.

## 6.4 LIMITATIONS OF THE STUDY AND FURTHER RESEARCH

This study has limitations resulting from the quantity of data collected. Due to the nature of this study only six teachers were meant to take part and only five actually did. The study was confined to a particular geographical area and followed a qualitative approach in which data was collected from a small sample, with the result that its findings cannot be generalised. The study focused on the teachers' use of resources to teach number concepts. However, number concepts comprise just one content area out of five. The use of resources to teach mathematics in the other content areas should be researched as well. A variety of similar case studies should make a significant contribution to the understanding of why South African learners perform poorly in mathematics. Future researchers may also include Grade R, as this is also part of the Foundation Phase.

## 6.5 RECOMMENDATIONS

The teachers of school A should sit and look at their lesson plans together to see what resources are required to teach concepts for the weeks ahead. They should then allocate a person in each grade to fetch the required resources from the LTSM kit. School B teachers should each put out their LTSM kit on a table in in the mathematics corner of their classrooms so that the resources are available for learners to use at all times. Learners should have a set of their own counters. They can collect bottle tops or sticks to keep in their bags or in containers on their tables to use when they need to. Teachers should also look at their CAPS documents and see what resources are recommended and how to use them. According to CAPS, certain resources are not concrete but abstract, like the flard cards and the number line. They should therefore be used with supporting materials in order to make sense to learners.

WCED should ensure that the tertiary institutions for teacher training include some basic mathematics language in the three languages of the province, English, Afrikaans and isiXhosa. Teachers should be able to translate words such as take away, add, and so on, into isiXhosa. Teachers should also use learners who are proficient in both English and isiXhosa to explain to those that do not understand what is going on.  Schools should try and involve the parents. Perhaps if they equip the parents with the necessary skills, they will be able to help their children in the language that they understand.

Time may be regarded as one of the most valuable resources in a mathematical classroom (Johnson, 2008). Using resources may be time-consuming but it is both necessary and compulsory in the Foundation Phase. Teachers should rather spend time following what CAPS recommends. The results may not seem visible immediately but at some point the learners will be at stage 3 of the ZPD and not need any assistance. One cannot but wonder whether fewer learners would need intervention if they were taught correctly in the first place. Teachers need to be patient with learners as proper teaching takes time. Teachers should also work on a time table, a lesson plan which will include the mat work, and the resources to be used in each lesson.

The CAPS document should be the starting point for all teachers. They should take time to read and understand it. The CAPS document indicates what to teach, how to teach and the resources to use. The results of this study showed that teachers do not know what to do with learners who struggle with mathematics. This suggests that teachers should attend more workshops and do some reading on educational matters to equip themselves to deal with the challenges they face in their classrooms. Teachers need in-service training and development to enable them to be more competent in their jobs (Posthuma, 2015). Teachers are reluctant to attend workshops after school hours, especially teachers who have been teaching for many years. At the current moment, curriculum advisors host compulsory meetings once per term to support and advise teachers on what and how to teach. All the teachers in this study attend those workshops and feel that they do help.

WCED should also follow up and do class visits to ensure that teachers are applying the methodologies taught at workshops. They should also give the HoDs time to conduct class visits to ensure that correct methods are used for teaching mathematics.

Teachers in the Foundation Phase should meet on a regular basis to discuss learners' challenges. Grade 1 teachers should inform the Grade R teachers what the learners are struggling to do in Grade 1. This will instruct the Grade R teachers as to which areas they need to focus more on. The same should happen with the other Grades. The Grade 2 teachers should speak to the Grade 1 teachers and the Grade 3 teachers should speak to the Grade 2 teachers, because although sociocultural theory states that teaching should start at the point where the learner is, not much of this is happening. This is because learners are far behind and the teachers have the current grade's work to cover.

## CONCLUSION

This chapter provided a summary of the entire research project. The results were discussed and factors contributing to the use of resources were highlighted. The limitations and significance of the research were considered and avenues for further research suggested. Recommendations were made to indicate ways to improve the use of resources to teach number concepts.

By understanding how resources may be used effectively, recognizing the challenges that teachers face with using resources, and implementing the recommendations made by this study, schools and teachers will be able to address the question of how best to use resources to improve mathematics results at their schools.

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# APPENDIX A: Letters of permission

Western Cape Government

Education

Directorate: Research

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

**REFERENCE:** 20140806-34195
**ENQUIRIES:** Dr A T Wyngaard

Mrs Lindiwe Mntunjani
68 David Atkins Street
Charlesville
Matroosfontein
7490

**Dear Mrs Lindiwe Mntunjani**

**RESEARCH PROPOSAL: THE USE OF MATHEMATICAL RESOURCES TO TEACH NUMBER CONCEPTS IN THE FOUNDATION PHASE**

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

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **02 February 2015 till 30 March 2015**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:
    **The Director: Research Services**
    **Western Cape Education Department**
    **Private Bag X9114**
    **CAPE TOWN**
    **8000**

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
**Directorate: Research**
**DATE: 11 September 2014**

Lower Parliament Street, Cape Town, 8001
tel: +27 21 467 9272 fax: 0865902282
Safe Schools: 0800 45 46 47

Private Bag X9114, Cape Town, 8000
Employment and salary enquiries: 0861 92 33 22
www.westerncape.gov.za

Cape Peninsula
University of Technology

68 David Atkins Street
Charlesville
Matroosfontein
7490
August 2014

Dear Teacher

**Request for permission to observe and interview the Grade 2 teacher**

I am currently affiliated with the Cape Peninsula University of Technology where I am registered for my Masters Degree in Education at the faculty of Education and Social Sciences. My research topic is "The use of mathematical resources to teach number concepts in the Foundation Phase".

I would like to obtain your permission, in principle, to obtain a copy of your lesson plans and observe you while at school. My role will be to analyse your lesson plans and to observe you in the classroom setting. In addition, I would like your permission to conduct an interview with you. Lesson observations will happen during the mathematics period so it will be part of the learning process.

I will require you to complete this consent form. I would like to inform you that all the information obtained from the lesson plans, observations and interviews will be kept strictly confidential and that the above arrangement can be terminated at any time. Please note that nowhere will your identity or the school's name be revealed in the research project.

Once I have received this letter giving me permission to obtain your lesson plans, observe and interview you, I will contact everyone concerned with the dates for the lesson plans the observations and the interviews. These will be done at a time suitable for everyone.

The research project, when completed will be available for you to view. Please feel free to contact me if you need any additional information regarding this proposal.

Yours sincerely

Mrs. L. Mntunjani

---

I Mrs. C. Shunmugam give you permission to use my lesson plans, observe and interview me the Grade 2 teacher.

Cape Peninsula
University of Technology

68 David Atkins Street
Charlesville
Matroosfontein
7490
August 2014

Dear Teacher

**Request for permission to observe and interview the Grade 1 teacher**

I am currently affiliated with the Cape Peninsula University of Technology where I am registered for my Masters Degree in Education at the faculty of Education and Social Sciences. My research topic is "The use of mathematical resources to teach number concepts in the Foundation Phase".

I would like to obtain your permission, in principle, to obtain a copy of your lesson plans and observe you while at school. My role will be to analyse your lesson plans and to observe you in the classroom setting. In addition, I would like your permission to conduct an interview with you. Lesson observations will happen during the mathematics period so it will be part of the learning process.

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The research project, when completed, will be available for you to view. Please feel free to contact me if you need any additional information regarding this proposal.

Yours sincerely

Mrs. L. Mntunjani

---

I Mrs. N. Dube .................... give you permission to use my lesson plans, observe and interview me the Grade 1 teacher.

Cape Peninsula
University of Technology

68 David Atkins Street
Charlesville
Matroosfontein
7490
August 2014

Dear Teacher

**Request for permission to observe and interview the Grade 2 teacher**

I am currently affiliated with the Cape Peninsula University of Technology where I am registered for my Masters Degree in Education at the faculty of Education and Social Sciences. My research topic is "The use of mathematical resources to teach number concepts in the Foundation Phase".

I would like to obtain your permission, in principle, to obtain a copy of your lesson plans and observe you while at school. My role will be to analyse your lesson plans and to observe you in the classroom setting. In addition, I would like your permission to conduct an interview with you. Lesson observations will happen during the mathematics period so it will be part of the learning process.

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The research project, when completed, will be available for you to view. Please feel free to contact me if you need any additional information regarding this proposal.

Yours sincerely

Mrs. L. Mntunjani

---

I Mrs. R. Booley.............. give you permission to use my lesson plans, observe and interview me the Grade 2 teacher.

Cape Peninsula
University of Technology

68 David Atkins Street
Charlesville
Matroosfontein
7490
August 2014

Dear

**<u>Request for permission to observe and interview the Grade 3 teacher</u>**

I am currently affiliated with the Cape Peninsula University of Technology where I am registered for my Masters Degree in Education at the faculty of Education and Social Sciences. My research topic is "The use of mathematical resources to teach number concepts in the Foundation Phase".

I would like to obtain your permission, in principle, to obtain a copy of your lesson plans and observe you while at school. My role will be to analyse your lesson plans and to observe you in the classroom setting. In addition, I would like your permission to conduct an interview with you. Lesson observations will happen during the mathematics period so it will be part of the learning process.

I will require you to complete this consent form. I would like to inform you that all the information obtained from the lesson plans, observations and interviews will be kept strictly confidential and that the above arrangement can be terminated at any time. Please note that nowhere will your identity or the school's name be revealed in the research project.

Once I have received this letter giving me permission to obtain your lesson plans, observe and interview you, I will contact everyone concerned with the dates for the lesson plans, the observations and the interviews. These will be done at a time suitable for everyone.

The research project, when completed, will be available for you to view. Please feel free to contact me if you need any additional information regarding this proposal.

Yours sincerely

Mrs. L. Mntunjani

---

I Mrs. ..G....Pillai.............. give you permission to use my lesson plans, observe and interview me the Grade 3 teacher.

Cape Peninsula
University of Technology

68 David Atkins Street
Charlesville
Matroosfontein
7490
August 2014

Dear

**Request for permission to observe and interview the Grade 1 teacher**

I am currently affiliated with the Cape Peninsula University of Technology where I am registered for my Masters Degree in Education at the faculty of Education and Social Sciences. My research topic is "The use of mathematical resources to teach number concepts in the Foundation Phase".

I would like to obtain your permission, in principle, to obtain a copy of your lesson plans and observe you while at school. My role will be to analyse your lesson plans and to observe you in the classroom setting. In addition, I would like your permission to conduct an interview with you. Lesson observations will happen during the mathematics period so it will be part of the learning process.

I will require you to complete this consent form. I would like to inform you that all the information obtained from the lesson plans, observations and interviews will be kept strictly confidential and that the above arrangement can be terminated at any time. Please note that nowhere will your identity or the school's name be revealed in the research project.

Once I have received this letter giving me permission to obtain your lesson plans, observe and interview you, I will contact everyone concerned with the dates for the lesson plans, the observations and the interviews. These will be done at a time suitable for everyone.

The research project, when completed, will be available for you to view. Please feel free to contact me if you need any additional information regarding this proposal.

Yours sincerely

Mrs. L. Mntunjani

---

I ~~Mrs.~~ Miss Kelly Allen ..... give you permission to use my lesson plans, observe and interview me the Grade 1 teacher

KAllen

## APPENDIX B:Lesson Plans

TERM : SECOND Grade 1A WEEK: 2 DATE: 17.04.2015

| | |
|---|---|
| **COUNTING AND MENTAL MATHEMATICS/ CALCULATIONS** | Count out objects reliably to 50.<br><br>☐Give a reasonable estimate of a number of objects that can be checked by counting. |
| | **Count forwards and backwards in**<br>☐ones from any number between 0 - 100<br><br>**Count forwards in**<br>☐10s from any multiple of 10 between 1 and 100<br>☐5s from any multiple of 5 between1 and 100<br>2s from any multiple of 2 between1 and 100 |
| **CONCEPT TEACHING/ WHOLE CLASS/SMALLGROUP WORK** | |
| **Group lesson** | Use the following techniques when performing calculations:<br>☐concrete apparatus e.g. counters<br>☐draw pictures<br>☐building up and breaking down numbers<br>☐doubling and halving<br>☐number lines |
| | Number range: 1-10<br>☐Add up to 10<br>☐Subtract from 10<br>☐Use appropriate symbols (+, -, = , ⭘)<br>☐Practise number bonds to 7 |

**Metro Central Education District**

**Circuit 3**

## MATHEMATICS LESSON PLAN

TERM : SECOND WEEK: 2 A

| | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
|---|---|---|---|---|---|
| COUNTING AND MENTAL MATHEMATICS/ CALCULATIONS | Count to at least 150 everyday objects reliably.<br>□ Give a reasonable estimate of a number of objects that can be checked by counting<br>□ Strategy of grouping is encouraged | Count to at least 150 everyday objects reliably<br>□ Give a reasonable estimate of a number of objects that can be checked by counting<br>□ Strategy of grouping is encouraged | Count to at least 150 everyday objects reliably<br>□ Give a reasonable estimate of a number of objects that can be checked by counting<br>□ Strategy of grouping is encouraged | Count to at least 150 everyday objects reliably<br>□ Give a reasonable estimate of a number of objects that can be checked by counting<br>□ Strategy of grouping is encouraged | Count to at least 150 everyday objects reliably<br>□ Give a reasonable estimate of a number of objects that can be checked by counting<br>□ Strategy of grouping is encouraged |
| | **Count forwards** and **backwards in:**<br>□ 1s from any number between 0 and 150<br>□ 10s from any multiple of 10 between 0 and 150<br>□ 5s from any multiple of 5 between 0 and 150<br>□ 2s from any multiple of 2 | **Count forwards** and **backwards in:**<br>□ 1s from any number between 0 and 150<br>□ 10s from any multiple of 10 between 0 and 150<br>□ 5s from any multiple of 5 between 0 and 150<br>□ 2s from any multiple of 2 | **Count forwards** and **backwards in:**<br>□ 1s from any number between 0 and 150<br>□ 10s from any multiple of 10 between 0 and 150<br>□ 5s from any multiple of 5 between 0 and 150<br>□ 2s from any multiple of 2 | **Count forwards** and **backwards in:**<br>□ 1s from any number between 0 and 150<br>□ 10s from any multiple of 10 between 0 and 150<br>□ 5s from any multiple of 5 between 0 and 150<br>□ 2s from any multiple of 2 | **Count forwards** and **backwards in:**<br>□ 1s from any number between 0 and 150<br>□ 10s from any multiple of 10 between 0 and 150<br>□ 5s from any multiple of 5 between 0 and 150<br>□ 2s from any multiple of 2 |

Adapted 1 November 2011: Elizabeth Fredericks Circuit 3

| | | | | | |
|---|---|---|---|---|---|
| | between 0 and 150 | between 0 and 150 | between 0 and 150 | between 0 and 150 | between 0 and 150 |
| | | | | | |
| | | | | | |
| **CONCEPT TEACHING/ WHOLE CLASS/SMALLGROUP WORK**<br><br>**SUBJECT AREAS:**<br>**NUMBERS OPERATIONS AND REALATIONSHIPS**<br>***(Math Kit - resources)*** | **Copy, extend and describe**<br>Copy, extend and describe in words<br>☐ simple patterns made with physical objects<br>☐ simple patterns made with drawings of lines, shapes or objects | **Group *: NEW LESSON**<br>**Concept:** Halving and doubling. | **Group *: NEW LESSON**<br>**Concept:-----------------** | **Group *: NEW LESSON**<br>**Concept:Halving and doubling** | **Practical Mathematics**<br>**E.g. Measurement: Telling the time**<br>**☐ Know days of week**<br>**☐ Know months of year**<br>**☐ Place birthdays, religious festivals, public holidays, historical events, school events on a calendar** |
| **PROBLEM SOLVING**<br><br>**PATTERNS, FUNCTIONS AND ALGEBRA**<br><br>**SPACE AND SHAPE**<br>***(Math Kit - resources)***<br>**DATA HANDLING**<br>***(Math Kit - resources)*** | Equivalent representations for the same number.<br>Twenty should be described as 2 tens (using the bundles or groups of objects) or 2 groups of tens.<br>.Describe, sort and compare 3-D objects in terms of:<br>☐ size<br>☐ objects that roll<br>☐ objects that slide | -Learners copy and extend different number sequences | Order whole numbers up to 99 from smallest to biggest, and biggest to smallest. | **Describe, compare and order numbers to 50** | **Group 1: Concept -Analyse and interpret data**<br>**Answer questions about data in pictograph** |
| **Content/skills**<br>(use the verbs) as a framework for/ to describe activities<br>***Workbook / Text book pages for Activities*** | Learners should start saying what each digit represents.<br>Ask learners: | | | | **Activities:** |
| | | | | | **1.** |
| | **Activities:** | ----------------- | ------------------- | ------------------------- | |
| | What number does the 7 represent in 27? | **Activities:**<br>the concept of groups of | **Activities: Which number comes just before 46?** | **Activities: Write the numbers in order from,the** | **2.** |

| Grade 1<br>Date: 27 April -1 May 2015<br>MATHEMATICS | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
|---|---|---|---|---|---|
| COUNTING<br>&<br>MENTAL CALCULATIONS | Weather and Birthday Chart<br>Count out objects reliably to twenty.<br>Count forwards and backwards from 1-20.<br>Identify, recognize and read numbers 1-20.<br>Allow learners to answer oral problems | | | | |
| Numbers, Operations and Relationships | | T introduces the number 8 to the L's. L's use fingers, counters etc. to show the quantity 8.<br><br>L's must write the number symbol in the air, on the chalk board, trace it in their book with a finger.<br><br>L's will **complete the activity on pages 74-75.**<br><br>In W.B, L's will show the number name, symbol and draw 8 pictures to show the quantity. | T introduces the number 9 to the L's. L's will use fingers, counters, crayons etc. to show the quantity of 9.<br><br>L's will **complete the activity on pages 76-77**. | T does a recap of number 9 with the L's doing examples from the previous day.<br><br>L's must write the number symbol in the air, on the chalk board, trace it in their book with a finger.<br><br>In W.B, L's will show the number name, symbol and draw 9 pictures to show the quantity.<br><br>**As consolidation, T will go over worksheets 8 and 9 in the S.A Teacher workbook with each group.** | |

| | | | | | |
|---|---|---|---|---|---|
| Patterns and Functions | | T will put up a number line 1-20 on the board for L's to count forward and backward.<br><br>T will then cover numbers from the sequence and L's need to identify the missing numbers. | | L's will copy the number pattern written on the board by the T, L's must then fill in the missing numbers. | |
| Space and Shape | | | L's discuss basic shapes: square, circle, triangle and identify them from a cluster of shapes set out by the T. | | |
| Measurement | | | | | |
| Data Handling | | | | L's will see how many of each shape they can find around the classroom and record their findings in their W.B | |

**Mathematics**

**28 April 2015** **08:30-09:30**

GR 1 B

Whole class counting

- Forwards and backwards in 1's (0-30)
- Forwards in 2's (0-30)

Whole class lesson and discussion

- Show and compare numbers 1-7 from **smallest to biggest** and then **biggest to smallest** with the learners. Choose learners to stand in front of the class with number flashcards.
- What number comes after 7? (8)
- Learners show eight fingers. Show the learners that 8 can be shown in different ways with their fingers but will remain same amount.
- Show the number 8 on the 100-chart.
- Write the number 8 in the air, on the table and on their friend's back.
- How many learners do we need to have 8 eyes?

Group work lesson

| Group 3- Smarties (W) | Group 2- Astros (A) | Group 1- Jellytots (T) |
|---|---|---|
| Learners must count out 8 beads:<br>• Make the symbol 8.<br><br>Learners must count out 8 sucker sticks:<br>• Take away 1 stick. How many left over? Take away 2 sticks, how many left over, etc.<br>Consolidation: **DBE pg 74-75**. | Learners use one-to-one correspondence cards:<br>• match the number symbol, number name and numerosity of 8.<br><br>Use chalkboards to:<br>• Write number symbol and name.<br>• Draw 8 objects.<br>• Cross out 1 object, how many left over? Cross out 2 objects, etc.<br>Consolidation: **DBE pg 74-75** | Each learner is given a number house card:<br>• Each 'house' has 5 windows. Each window must add up to 8.<br>• Learners must copy the work card into their books and complete.<br>Consolidation: **DBE pg 74-75** |

[redacted] Primary School

**MATHEMATICS** **Gr. 2 B** **7 hours / week → 420 min / week**

**Date: 20- 24 April 2015** **Term: 2** **Week : 3**

| | | |
|---|---|---|
| DAILY COUNTING: *Up to 180.*<br>*5 Min*<br>*Whole Class* | <u>Number Range</u>: 0-120<br>-Estimation of objects that can be checked by counting.<br>- Grouping and counting of objects up to 50.<br>-Counting forwards and backwards in 1s, 2s ,5s &10s from any number between 0-100.<br>**Homework DBE book pages 78-83** | |
| MENTAL MATHS:<br>10 Mins<br>Whole Class | **Number Range:** 0-50<br>-Learners will use calculation strategies to add and subtract numbers up to and from 20,SA Teacher page 46.<br>-Ordering a given set of selected numbers. | |
| REVISION & NEW CONCEPT: ( CLASS ACTIVITY)<br>10 minutes<br>Number range 0-200 | **<u>Numbers, Operations & R/ships :</u>**<br>-**Place Value**: Learners will use base 10 blocks, working in groups of four to show the value of numbers and showing that same number using flard cards. Learners do at least five numbers and then ordering them from the smallest to the biggest. Page 20 Sa Teacher book<br>-**Number names** up to 30 & symbols up to 50<br>-**Place Value:** Learners add tens and units to find answers and draw tens blocks to show this i.e 10+2= etc | |
| | **<u>Geometric Patterns</u>**<br>Learners identify shapes and colours used in making patterns. DBE blue book page 74 | |
| | **<u>Measurement;</u>**<br>**Time:** Learners use the calendar to say the days of the week, the day before and day after.<br>Learners practice telling time at hourly and half hourly intervals during the school day, using the classroom clock.<br>**Mass:** learners will look at given objects and write the mass of each object and the mass of two different objects. | |
| Group Activity | <u>Monday:</u> | <u>Tuesday</u><br>**<u>Group 1 (Concrete)</u>**<br>Learners count on from 20 using objects base ten blocks, beads and tops.<br>**Problem solving:**<br>Mum gave me 2 more marbles than my brother who has 24 marbles. How many marbles do I have?<br>**<u>Group 2 (Representative)</u>**<br>Learners work individually to complete a worksheet<br>**Problem solving:**<br>Mum gave me 2 more marbles than my brother who has 24 marbles. How many marbles do I have?<br>**<u>Group 3 (Abstract)</u>**.<br>Learners draw groups of ten to show numbers 26-29 eg 26 will be 2 groups of ten and 6 ones. |

| | | |
|---|---|---|
| | | **Problem solving:**<br>Mum gave me 2 more marbles than my brother who has 24 marbles. How many marbles do I have? |
| | Wednesday:<br>**Group 1 (Concrete)**<br>Learners use base ten blocks to show the numbers 41-50,saying what number comes before, after and in between and **solve the problem:**<br>at the bottom of the DBE page 81<br>**Group 2 (Representative)**<br>Teacher writes numbers 44-48 then learners make drawings of each number using base 10 blocks and flard cards **solve the problem:**<br>at the bottom of the DBE page 81.<br>**Group 3( Abstract)**<br>Learners will work individually to complete work in the DBE books on page 81 and **solve the problem**<br>at the bottom of the page. | Thursday:<br>**Group 1 (Concrete)**<br>Learners give family facts of 34 by using the tens and ones blocks, saying which number comes before and after 34.<br><br>**Problem solving:**<br>Learners solve a problem with an answer of 34<br>**Group 2 (Representative)**<br>Learners work individually to write all family facts of 50.<br><br>**Group 3 (Abstract)**<br>Learners give family facts of 46 by using the number line, saying which number comes before and after 46.<br>**Problem solving:**<br>Learners solve a problem with an answer of 46 |
| VERRYKING &INTERVENSIES / ENRICHMENT & INTERVENTIONS | Mathematics workbook 1 of 4<br>Worksheets.<br>DBE workbooks<br>S A Teaacher Teacher's guide and workbook. | |
| RESOURCES/BRONNE COMPUTER/REKENAAR | Workbook DBE books &Study & Master<br>Counting Chart<br>Counters | |

H.O D Signature: ________________________

[redacted] *Primary School*

**MATHEMATICS Gr. 3 B** — **7 hours / week → 420 min / week**

**Date: 28 – 30 April 2015** — **Term: 2**

**Week : 3**

| | |
|---|---|
| **DAILY COUNTING:** *Up to 180.*<br><br>*5 Min*<br><br>*Whole Class* | **Number Range:** 0-500<br>• Estimation of objects that can be checked by counting.<br>• Grouping and counting of objects up to 500 in groups<br>• Counting forwards and backwards in 1s, 2s ,3s, 4s, 5s &10s from any number between 0-5 |
| | **Number Range:** 0-500<br>• Learners will use calculation strategies to double and halve numbers up to 20<br>• Ordering a given set of selected numbers.<br>• Comparing numbers and saying which is more or which is less 21 or 12, 14 or 24, 13 or 31 etc.<br>• Recalling addition and subtraction facts up to 20. |
| **NEW CONCEPT:**<br><br>**Class Activity 10 minutes**<br><br>**Number range 0-500** | **Numbers, Operations & Relationships :**<br>• Use of number line<br>• Break down numbers into 100's, 10's and 1's<br>• Order numbers<br>• Problem solving: addition, subtraction, doubling, halving |
| | **Number Patterns**<br>• Sequence numbers from biggest to smallest and vice versa<br>• Give 5 numbers more than___<br>• Give 5 numbers less than ___<br>• Number sequencing in 2's, 3's, 4's and 10's and 100's |
| | **Measurement:**<br>**Time**<br>• How many minutes in 1 hour?<br>• How many months in 1 year?<br>• Show the time in hours and half hours on an analogue clock<br>**Capacity**<br>• Recognise heavy and light objects |
| | **Space and shape**<br>• Count the straight and round sides of objects<br>• Name 3D objects |

| | Monday | Tuesday |
|---|---|---|
| **Group Activity (not done last week due to disruptions)** | **Group 1 (Concrete)**<br><br>Public Holiday 27 April | **Group 1 (Concrete)**<br>• Give learners base 10 blocks to count up to 100<br>• Ask learners what number is between 2 given numbers<br>• Problem: My secret number is smaller than 342 but bigger than 339. What could my secret number be? |

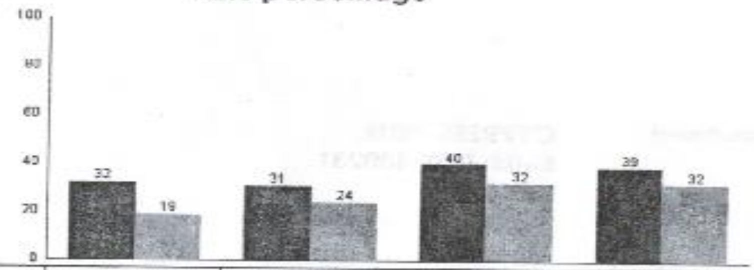
| | | |
|---|---|---|
| | | Count in multiples of 10 forwards and backwards |
| | **Group 2 (representative)**<br><br>**Group 3 ( Abstract)** | **Group 2 (representative)**<br>• Addition in 10's and 1's using base 10 blocks<br>• Show the number in between 2<br>• numbers using flard cards<br>• Multiples of 10 forwards and backwards<br>• Solve the same problem and show it with place value cards<br><br>**Group 3 (Abstract)**<br>Learners work independently to complete work on board<br>• Solve the above problem |
| | Wednesday:<br>**Group 1 (Concrete)**<br>• Use base 10 blocks to show numbers<br>• Learners to count in multiples 3's, 5's and 10's<br>• Addition in 10's and 1's<br>• Double the numbers: 36 48 47<br>**Group 2 (Representative)**<br>• Learners to show numbers asked using flard cards<br>• Eg: 169<br>• Now show a number that is 1 less<br>• Learners to count in multiples of 3's, 5's and 10's<br>• Addition in 10's and 1's<br>• Double the numbers 46 68 39<br>**Group 3( Abstract)**<br>• Learners work independently to complete work on time<br>• Addition in 10's and 1's<br>• Double the numbers 68 76 54<br><br>Heavy and Light<br>Strawberry, apple, car, elephant, cow, mouse | Thursday:<br>**Group 1 (Concrete)**<br>• Learners to count In multiples of 2's, 10's and 100's<br>• Subtraction 10's and 1's<br>• Halving : 74 68 32<br><br>**Group 2 (representative)**<br>• Learners to use base 10 blocks<br>• 1's<br>• Halving: 48 64 36<br><br>**Group 3 (Abstract)**<br>• Learners work independently to complete work on board<br>• Subtraction in 10's and 1's<br>• Halving: 94 72 64<br><br>How many minutes in 1 hour? In half hour?<br>Draw shapes that can Slide or Roll<br>Friday:<br>**All Groups**:<br>Public Holiday 1 May |
| VERRYKING &INTERVENSIES / ENRICHMENT & INTERVENTIONS : | Mathematics workbook 2 of 4<br>Worksheets.<br><br>DBE workbooks.<br>Games | |
| RESOURCES/BRONNE COMPUTER/REKENAAR | Workbook DBE books &Study & Master<br>Counting Chart<br>Counters<br>Blocks.<br>CAPS document. | |

## APPENDIX C: Grade 3 Results

### Grade 3 results

**Progress in Mathematics and Language**

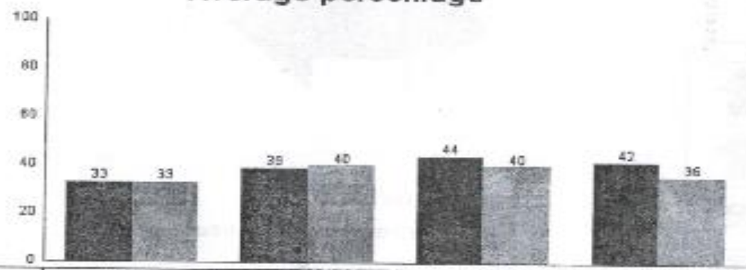
**Pass percentage**




| | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Mathematics Results (%) | 32 | 31 | 40 | 39 |
| Language Results (%) | [redacted] | [redacted] | [redacted] | [redacted] |

The graph and table on the left indicate the percentage of learners who achieved 50% and higher from 2011 to 2014.

**Average percentage**




| | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Mathematics Results (%) | 33 | 39 | 44 | 42 |
| Language Results (%) | [redacted] | [redacted] | [redacted] | [redacted] |

The graph and table on the left indicate the average score for the school from 2011 to 2014.

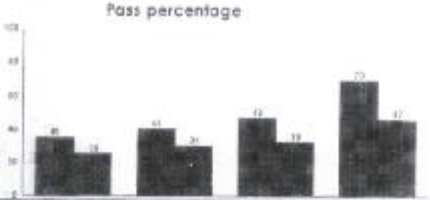
Refer to Principal's letter for explanation of pass % and average %.

To compare performance of your school to similar schools, refer to Principal's letter for quintile and fee status information.

## Grade 3 results

**Progress in Mathematics and Language**

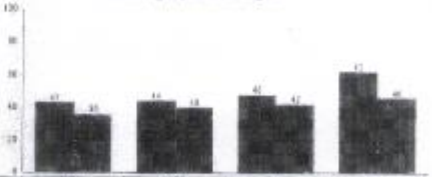
### Pass percentage



| | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Mathematics Results (%) | 36 | 41 | 48 | 70 |
| Language Results (%) | [redacted] | [redacted] | [redacted] | [redacted] |

The graph and table on the left indicate the percentage of learners who achieved 50% and higher from 2011 to 2014.

### Average percentage



| | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Mathematics Results (%) | 43 | 44 | 48 | 62 |
| Language Results (%) | [redacted] | [redacted] | [redacted] | [redacted] |

The graph and table on the left indicate the average score for the school from 2011 to 2014.

Refer to Principal's letter for explanation of pass % and average %.

To compare performance of your school to similar schools, refer to Principal's letter [illegible] information.

## APPENDIX D: Interviews

**School B**

**Grade 3 teacher**

**1. What is your highest qualification?**

**How many years did you study?**

**2. How many years have you been a Foundation Phase teacher?**

**3. Have you taught any other phase?**

**4. Till what Grade did you do Mathematics in school?**

**5. Did you experience difficulty in Mathematics at school?**

**6. Do you experience difficulty teaching Mathematics? Elaborate.**

**7. Do you have all the mathematical resources stipulated in the CAPS document?**

**8. Do you always follow your lesson plan? If no, explain.**

**9. Do your lessons always go as planned? Explain.**

**10. What is the purpose of using resources when teaching Mathematics?**

**11. How do you help your slower learners or those that are just not getting it?**

**12. What is your opinion on content area number 1: Numbers operations and relationship? Is it more important than the other content areas? Elaborate.**

Teacher 3B

Has 41 learners.

School B

1. Her challenges are: Language barrier firstly, discipline um, too large a number uhm, in terms of working with groups. The discipline goes all hay wayer. Then, I think my most, the difficult one, is the language barrier because they don't get the concepts, they can't grasp the concepts, uh, uh, as opposed to Home language its different but I think with mathematics its more difficult.

2. It's very difficult to always teach in groups. I think in reality dealing with the number of learners that I am faced with, it's not possible to do it all the time. As well as the amount of work that needs to be covered per term, it doesn't give you the opportunity to deal with grouping, uh, group work all the times.

3. I wouldn't say lessons always go as planned because we have slow learners, that or they don't get the concept. You would have to reinforce again, so I don't think it always goes accordingly. But I think relatively, we more or less on par for the week you know or maybe a day or two, but otherwise mostly, most of the time. But unfortunately with some of our fundraising activities or we have church so those days go out.

4. I've got uhm, very few Afrikaans, English and isiXhosa.

5. Not isiXhosa, I can speak Afrikaans.

6. You mean teach in their home language when teaching them a specific subject? I wouldn' t say so, I would, If I'm teaching mathematics I'm teaching just English I speak English. I don't ever teach them in their home languages, in frikaans or in isiXhosa.

7. I would think erm, too much of uhm uhm, the curriculum itself expects too uh of the learner in such a short space of time. So hence, its difficult to cover so much in a short space so you don't have enough time to consolidate whatever concept you're teaching so hence they just not fully equipped or understand it.

8. We just revise whatever we have done. Uh also you know the terms uhm that's used we try to you know instead of just saying subtraction we say take away, less than or. Just to try and make them understand what the concept is. We use the exemplars, the previous years just to try and make sure, do as much as possible to gear them towards the ANA.

9. I've taught in the Foundation Phase for 5 years. This is my sixth year.

10. I am a qualified Foundation Phase teacher. I have a BEd in Foundation Phase.

11. I didi mathematics in high school till Grade 12.

12. In general I wouldn't say I experienced difficulty in mathematics @ school.

13. I would say I have all the recommended resources. I would just think that the issue for me is the large number of learners to actually, you know to be able to utilize everything. The large number of learners and uhm uhm, I think it's just a bit too much work to fit into 1 term. There's just not enough time to do everything in that short space of time with so many learners and then you have this curriculum that has to be taught in this eight weeks. If you sit with one concept for too long, you gonna lag behind with the rest of the concepts that need to be taught.

14. For the learners especially with concrete material and concrete resources. I think that would really make it, it does make a difference coz you take them back to the basic, the foundation for them to grasp that concept from the beginning with um your, uhm, blocks and things for them to actually develop that concept. It does, it makes the difference. I think that would be an ideal environment, to work with those resources but we not working in an ideal environment and there needs to be work in the learners' books.

15. I would say we use it for certain concepts during the week, just to uhm, I wouldn't think, I wouldn't say I would use it for all my learners, I think I use it more for the weaker groups, just to try and you know make them understand those concept that theyre having a problem with.

16. Concrete material, concrete resources yes. Coz then you going back to the very basics which is what they would require. Which is what we actually do with them.

17. No I don't always have time to teach everything.

18. Number operations. I think, uh yes I would think number operations where they really struggle getting that repeated addition, or grouping and sharing. I basically cover everything on a daily basis, no not on a daily basis, on a weekly basis. I would say most of the content is covered. But I would say number operations is dealt with daily. But obviously I don't do all on the same day. We actually split up 2. 1 number operation for two days. So they grasp it, the second day is more of a consolidation. So in two weeks I would do uhm so I would say the first week is 2 days of addition, 2 days of subtraction. The next week is 2 days of multiplication and 2 days of division and the fifth day of both weeks is either my money or fractions just to try and , yah.

19. Because I feel. I, Im not saying im not doing the rest. We doing our datahandling. If I'm doing number operations, with that goes my data handling or my space and shape or uh you know

which ever other or the number patterns but on those days, included in those days, im doing number operation.

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<u>Teacher 1B</u>
<u>School B</u>

1. 33 learners.

2. I think more than, before maths I would say just in general, the language barrier. So in order for me to explain a concept, I first need to break down what I'm saying into simpler form. Then you also have those learners where some of them are just completely lost with the numbers like some of them write it the wrong way or can't do it in the correct order. But I would say that the main problem would be the language barrier because some of them don't understand necessarily what I'm doing on the mat or whatever.

3. Most times. Sometimes I do, I must admit I do whole group especially if it's a new concept. I would take a bit longer with that concept and do whole group and then the next day I would then spend more time with my smaller groups than my whole group. So normally I take out a whole week and then each day I plan it so that by the end of the week they understand that concept. So it's a mixture of whole group and smaller groups.

4. Not at all, not at all. You will always expect that 1 child that needs extra help with, like repetition of a concept or theres children that fight cause they don't wanna share the counters or it can be many, many things. Sometimes ill be on the mat with the children and maybe I didn't think of maybe the child asking this one particular question or needing me to explain a part of the concept and that would take like a extra 15 minutes from what I had planned on the lesson plan. So actually I don't think it actually ever goes according to plan actually.

5. Out of the 33, 20 are isiXhosa 11 are English, 1 is Sepedi and 1 is Setswana. Some of the English speakers speak Afrikaans at home but they understand their English so I don't have to translate cause they do understand.

6. (teacher laughs) No. I know my numbers in isiXhosa and like my basic like kuyabanda. I know the basic words but no. Only when we do the first additional language then I teach Afrikaans.

7. I would think. Well I would have to take some experience from us as a school but I would think theres so much emphasis on marks, marks, marks and certain things need to be done in certain number of weeks and assessment 1 must be done after 4 weeks. Like I said, a

lesson never goes according to plan. So a concept might take me 2 weeks instead of a week, but because assessments need to be done in 4 weeks, im now rushing and some of the children don't understand. The weaker children are even more lost than what they usually are because I think it comes down to a lot of pressure, that pressure of marks. So even us a teachers, without even realizing it, because we get pressure from higher authority, we start putting the pressure on the children, especially with doing work. We say come guys, be quicker where they maybe just need that extra time to understand a concept.

8. I'm actually busy with that right now because I also have to bear in mind that it's going to be third term assessment as well. So it actually thinking how to get all the work in a short space of time. Cause now tats extra weeks cause ANAs is taking away time for extra revision and stuff. I'm using past papers that you obviously get from the website. I go through that but obviously I also take longer to explain cause obviously with ANAs you can only read the question, you can't tell them what to do so now I break it down. We read the question like if it says Ann has 8 sweets, we discuss is it a minus of a plus, is he taking away, is she adding? So it's a lot of explanation that I'm doing now but also with the bigger number range, it's trying to introduce the number range. It's quite crazy but I try to day by day. So I'll see after the ANAs if it worked or not.

9. 5 years experience.

10. Yes. BEd Foundation Phase

11. Yes I did maths in high school. Till matric

12. Definitely, I experienced problems with maths but I enjoyed it.

13. Yes I have the most of the resources but I would love to have more resources. Like I have the counters, the sticks and the stuff. But you can never have enough resources. And also I don't have 33 of each resource. So its groups of 11 but sometimes I only have 8 of a particular resource then I will need an extra 3. So the resources are not always enough for the big small groups I have.

14. Definetly like with studying also it works if you start with touch, feel, see, smell. So especially with those children that struggle, it's easier for them to take something and say right, so this is one and put it aside, pick up another one, if you put it together it's two. If you take one away its like minus, so like resources are very important cause even with the top learners, they might know what going on but for them to touch and like with the flard cards and like sucker sticks. When explaining any concept, things like counters are amazing, things like sucker sticks, later on when you do flard cards its amazing how these children need to see it infront of them. You can't just tell them 4+3. They need tactile at this stage.

15. That takes a lot of time which you don't always have but sometimes you make the time. As a teacher you make the time. Like right now what they're struggling with is the plus and minus of bigger numbers. Now obviously, the weaker children would use their fingers but now obviously we working with bigger numbers bigger then ten. So they'll do 6+5 and run out of fingers and automatically their answer would be 10. So with the weaker learners they need a lot of one on one and like I say with the resources, they must touch, they must construct something and tear it apart. It's a lot of one on one, having to tell them what to do. Then they forget and its reoetition of what I told you yesterday. Then it happens tomorrow and you start all over again especially those with learning barrier. The first time I would do it and then have one of their friends who maybe understand English better just to do the translation. Cause sometimes they look at like they don't know what you're talking about. I think maths is easier to teach to someone with language barrier cause it's a universal language. Plus is plus. Its easier than teaching them to read and write. The learners do get it eventually through repetition helping and showing them before they can do it themselves. Helping them with their confidence, cause if they don't know whats happening, they wont feel very confident. Its also about motivating them. Telling them they can do it and they must take their time to make sure they not doing any mistakes.

16. You don't have time, but you make it cause at the end of the day the child needs to have the best of everything before the end of the year. Sometime the teacher has a headache at the end of the day or they don't have enough time for something but you make a plan somehow somewhere. Yes sometimes I take from other subjects. I know it's not a good thing like here is my time table but manier time I go over that time for maths.

17. Numbers and operation. In order for you to understand the patterns and the shape and measurement you need to understand you basics which is numbers operations. Cause some of them are still struggling with the counting. So obviously if you doing patterns, you doing counting I twos now you need to fill in the missing numbers. You need to know how to count first before you can do such patterns.

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<u>Teache 2B</u>
<u>School B</u>

1. 42 learners

2. I find children are not interested in grappling mathematical problems. Especially I've a big problem with story sums, prblrm solving. Children simply don't understand it. Their comprehension skills seem to be so poor.

3. Sometimes I find it difficult. Ive got a very small classroom but a very large number and a lot of learners who are actually in the bottom group. It makes it difficult. I try to but its difficult.

4. No. no. its interference from the SMT not just the smt but other programmes at the school. Fundraising included which I find id ridiculous and too much. So it sort of interferes with the lesson plan. Sometimes it's necessary to go back when the children don't understand.

5. Afrikaans, Englisha and isiXhosa

6. No, Afrikaans I struggle with Afrikaans.

7. I try to as much as I can but I find that even the Afrikaans learners aren't so confident in Afrikaans.  Xhosa learners do understand their language but not Afrikaans. I don't think their mothers converse that much in Afrikaans with them.

8. I think it's the attitude from parents and the curriculum is heavily loaded, you don't have a, I find sometimes I brush through things simply cause I have to get through the curriculum and when CAs come, you have to have covered everything. So at the same time were robbing learners but were being pushed. It's too much work in the Foundation Phase and we need more time but the children can't be in school the entire day it affects them.

9. Revision from day 1. When they get to Grade 2 we start doing things that are geared towards the systemic and ANA. I look at the previous ANA and I make sure when teach I amphasise things that I know will appear. You sort of get to know how the structure of the paper is so you try abd teach using that structure.

10. 5 years

11. Yes and intersen. Initially senior phase, then I decide to change to Foundation Phase. Ace Foundation Phase. HND for senior phase in Zimbabwe. In Zimbabwe that is high school. You are either a primary school teacher or a high school teacher. So I came her and studied Foundation Phase (Ace).

12. Not really. I actually enjoy teaching maths more than the other subjects.

13. Yes. The school tries to provide but I find I have to find my own stuff ahich I do most of the time.

14. To consolidate and to enhance understanding.

15. During teaching time and even after. It doesn’t have to be in a structured, formal teaching atmosphere. During interval, I try to engage kidz in those resources as and when they feel. I don’t use them in every lesson, it’s not practical. I find as much as I’d love to, it’s just not practical with the time constraints. It depends on the complexity of things that need to be done. If I need to, I do. I don’t use the same resources for all the learners. I find that the top group doesn’t need resources all the time but sometimes they do.

16. I try to but they just never get to understand. I’ve got a child who still doesn’t know how to add 5+5. I was actually frustrated.

17. No, no, no and I don’t think I ever will. Like I’ve said I have a big problem with the new curriculum. It’s very heavy. It’s very heavy. I don’t know. That’s my opinion.

18. To be honest, I find myself most of the day doing number operations. Almost the entire session. Sometime it goes to the second session. Because I know there’s a problem there and it would be unfair just to go through things and leave some things that I know are more important and the results.

## APPENDIX E: Lesson Observations

Observation One

Addition School A, Grade 1

Pegs and plate

Number line up to 10

Maths vocab

Shapes

Number chart

Maths table with resources not visible

12 learners- Top group

Total number of learners in class

Teacher handed out number-lines up to ten for learners to paste in their books. Teacher had a big one, like the learners', pasted on the board.

Teacher gives clear instructions.

Teacher asks learners what we call a number line. The word number line is introduced. The numbers are counted and teacher asks what number they stopped at, learners answer. What number they started at and learners answer in chorus 1.

Teacher has flashcards with numbers up to 6 and asks learners to show the number on the number line. Teacher then asks the learners to put up that much fingers. Teacher does different numbers randomly and checks that the learners are showing and pointing to the correct number on the number line.

Teacher asks what the biggest number is that she showed them and what the smallest number is. Teacher then asks one learner to place flashcards under the correct number on the big numberline. (match the numbers) numbers are not given in sequence.

Learners are then given cokies and asked to make a dot on the number 2. Teacher demonstrates on the big numberline. Teacher explains that they are by number 2 now. If they need to get to 6, they must do hops. The hops she explains must be done in pencil now and not cokie. Teacher explains how they must go to each number and can't just jump to number 6 and they must count while hopping.

One of the learners was asked to show how they hopped on the big numberline using chalk. Teacher looks around and sees some made more hops than asked. Teacher then tells the learners to count the hops that the learner made on the board. Then learners had to count their hops to see if they have the correct number of hops. Teacher tried to help the learner who had more hops by counting and demonstrating on the bigger numberline on the board.

Teacher asked the learners what number they started at and learners say 2. Teacher writes 2 on the board and asks how many hops did we make. Learners answer 4. Teacher adds 2+4 and asks what number did we land on and the learners say 6. Teacher writes 2+4=6 and asks learners if they can see how they can use numberlines to do sums. Learners say yes, and teacher asks if 2+4 is really 6 and learners say yes.

Learners are asked to do the same but now on their own. Learners must get to 6 again but start at 1 this time using their cokies to make a dot on number 1. Learners use the same numberline and the same colour cokie. Learners are getting confused and copying what's on the board and are told to erase. Teacher realises she should have given another numberline because it is difficult to see two sums on it now. She hands out a second numberline and learners are told to start at number 3 and stop at number 6. Learners are told to hop all the way to number 6. The learner who struggles is now doing much better.

Teacher drew a minus sign on the board and asked if the numbers are going up or down showing direction on the numberline using her hand for up and down. She asked which sign must she use – or +. Are the numbers going up + point at the plus sign or down, pointing at the – sign. Learners said +. Teacher did the same and wrote 3+3=6.

Some learners wrote +3=6 and some wrote +3 only. Teacher showed them on the board what the sum is.

Learners got a third numberline and were told that now they are going to do a special sum. The learners are told that now they are going to start at number 6. They must start at 6 and stop at 6. So what number do we use when we don't hop? Learners answer 10. Teacher says no. Learners give all other numbers until teacher shows them on the board and writes 6+ and asks them, did we make hops? So what is that number? What is that round number? Learners answer 0. Teacher then writes 6+0 and asks what number did we stop at? Learners say 6 and the teacher writes 6+0=6. Learners are asked to complete this last sum and go to their tables when they are done.

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Observation Two

22/04/15

Grade 2

School A

Mrs Booley

Introduction, today, tomorrow and the date.

This year is _ learners say April. Teacher asks what do we always write after April? 2015 learners say twenty fifteen and the teacher says yes, two thousand and fifteen.

Learners say the days of the week and months of the year. Teacher asks which month comes after April, teacher asks one learner to answer. Learners answer in chorus. Learners say March. Teacher rectifies learners and explains before and after.

Learners count on the counting chart in tens starting at number 10 up till 200. Teacher tells learners that the number is getting bigger and bigger by 10.

Teacher then asks the learners to count backwards in 10s. Teacher asks one learner and points to the numbers.

Learners then use a different chart to count in 2's. Teacher helps learners by pointing at the numbers. The chart is a chart with only multiples of 2. Teacher then asks one learner to count in 2's starting at any number. She asks one learner to count in 2's starting at 74. Learner counts while the teacher is pointing to the numbers. Teacher then asks one learner to count backwards starting at 28.

Teacher then uses the 3 number chart (number chart with multiples of 3) and asks the learners to count in 3's. Teacher then asks one learner to count in 3's while she points.

Learners say number names (number name 6, word 6, number name 7, word 7). They recite this.

Teacher then gives learners sums on a chart to read. The chart has sums (number sentences without answers) and have to answer.

Teacher then asks learners to answer one by one (sums) number sentences and tells them to stand if they don't know the answer. Teacher then does mental maths: double 5, half of 20, half of 40, 60, 100. Learners answer in chorus.

Teacher then tells the learners to go back to their tables in groups (red, yellow).

Teacher gives yellow group a worksheet counting even numbers. Count the number of children hiding behind trees, doubling and halving.

The teacher then takes a group on the mat and each learner comes with a pack of flashcards. The teacher hands out a page with numberlines and tells the learners that they are going to be adding 10.

Teacher asks the learners to pack out 10. Teacher uses her own pack to ask the learner to identify all the 10s as she flashes them to the learners.

Teacher tells the learners to pack out the 10s. 10, 20, 30, 40, 50, 60.

Teacher tells learners they must add 10 to any number.

Teacher then, while learners are packing, takes her flashcards and starts asking questions about the number she has in her hand '27'. The teacher then asks which number is bigger, the 2 or the 7 and tells them the 2 is not actually a 2, it is a 20. Then she asks again showing the learners this time the number broken down. 20 and 7 and asks the learners which number is the biggest. The learners say 20. When the numbers is put back together, the learners still say 7 is bigger. Teacher discusses this and breaks up the number and asks how many tens are in 20 and then puts the number back and reminds them again that 2 is 20 and 7 is 7. So which one is bigger, 20 or 7? Learners say 20.

Teacher gives another number '34' and does the same. She then asks the learners what plus sum they can make with 34. Teacher breaks up the flashcard into 30 and 4 and one learner answers 30+4. Teacher then gives the learners the following sums, 10+4 the learners answer 14 and the teacher gives more 10+2, 10+1, etc. Then the teacher gives 10+4, 14+10, 24+10 and the learners answer. The teacher tells the learners that the numbers are getting bigger by 10.

Teacher gives the learners different sums to do on the numberline and shows an example of 10+7 on the board and how to do it on the numberline. Some of the learners do not understand and just copy what the teacher is doing on the board. Some did exactly what they were told and used the sum that the teacher verbally gave them. Learners were then told to pack away and do one activity at their tables. The activity was drawn on the board and learners had to copy from the board.

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<u>Observation Three</u>

Grade One      School B

Introduction

Teacher explains to learners that they are going to count from 1 to 30. She asks one learner to show on the big number chart on the board where number 30 is so that they know where to start. Learners count in 1's from number 1 to 30. Teacher then tells the learners they are going to start at 30 this time. She then asks the learners what they think is going to happen now. Then she explains that they are going to count back and she uses the word reverse to be more explicit. Teacher also uses the term red robot for the number at which the learners must stop counting (30). Learners then do the same but counting in 2’s this time.

Teacher asks the smarties group to come to the mat and each learner is given a card with a number. She then tells the one sitting to say the numbers of each child she touches. Learners say the numbers as the teacher touches the learners. She then praises the learners. Then asks the ones sitting to order the numbers in the correct order from the smallest to the biggest. The learners sitting then say out loud who must stand where based on the number they’re holding. Teacher uses the word ‘after’ and ‘order’. She asks questions like: who’s after a certain learner etc.

She then lets the children face the other way and reshuffles them. They then face the learners sitting again and say the numbers. They do the same but now order the numbers from biggest to smallest. Teacher asks who’s got the biggest number, who comes next, what number does he/she have? etc.

Learners say the numbers from biggest to smallest. 7 is the biggest number. Teacher then introduces number 8. She asks the learners which number would come after 7 and one boy who was standing on the side with the number 8 joins the line and stands after the learner with number 7.

Teacher tells the learners that they are going to be busy with number 8. She asks one learner to show  or point at the number 8 on the board.

Learners are then asked to make 8 on their fingers. Teacher explains that there are different ways to make 8 on our fingers and asks a few/3 learners to stand in front and show the class the different ways to make 8. Learners count the fingers to make sure it’s 8. Learners draw 8 in the air. They draw 8 on the tables with their fingers. They draw 8 on each other’s backs.

Then the teacher asks: how many eyes does one person have? They answer 2. So she asks: how many learners must stand in front to make 8 eyes? One learner answers 8. Teacher calls 8 learners to come in front and the learners count. Teacher encourages learners to count in 2’s. The learners come up with different possible numbers and teacher calls the learners and the class counts until they say 4 and get it right.

Teacher then asks how many children make 8 eyes and the learners answer 4.

Teacher tells the smarties (10 learners) to come onto the mat while the others hand out blue books.

Teacher attends to the children with blue books and tells them which page to go to while the learners on the mat take turns to take out 8 blocks from a tub/container.

Each learner is now sitting with 8 little blocks. Teacher asks each learner to count how many blocks they have one at a time. She puts the number 8 in the middle and asks the learners to make the number 8 with their blocks (number symbol). The learners struggle to make 8 with their blocks. Then the teacher tells them to make a small 8 otherwise there won't be enough blocks to make 8. Teacher then demonstrates and makes her own 8 as the learners were struggling on their own.

Teacher then gives the learners a tub with sticks and tells the learners to take out 8 each. Learners start making the number 8. Teacher tells them that wasn't the instruction; they must just count the sticks. Learners count the sticks and then teacher says: take one stick away. Learners do so and the teacher asks how many are left. Teacher does the same and asks them to take away 2 and then count the remaining amount. Learners answer correctly and say 6. Teacher tells them to take away 4 and they count the leftover sticks.

Teacher then brings a blue book showing the learners what they must do at their tables.

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Teacher takes a different group and gives them cards. Some of the learners have the cards with the word 8 and some with the symbol 8. Teacher asks the learners; who has the number 8, who has the word 8? Learners put up their hands. They are then told to find a card that matches their's.

Teacher then hands out dot cards. The dots on the card are placed differently. Teacher asks the learners to count the dots on the cards. Learners say 8. Teacher asks what is the same with all the cards? Learners say 8, they all have 8 stickers. Teacher asks what is different?

Teacher then gives the learner other cards with the outline of the stickers to match with the dots cards.

Next, the learners get a board and chalk to write the number 8 and the number (words) name eight. Then they are asked to draw 8 things. Any 8 things.  The teacher then tells one learner to count how many he has. He counts 7 and the teacher tells him to draw one more.

Teacher then tells the learners to take one away and count how many is left over. They do the same and take away 2 and count how many is left over. The teacher then tells them to take away 5 and count how many is left over. They take away by drawing a line in a shape with their chalk.

Teacher takes the last group on the mat. Each learner gets a house with number 8 on top. Teacher tells the learners to count the windows of their houses. They all have 5 windows. One side of the window has dots and the other has none. Teacher explains that each row must have 8. So how many must they draw in each row to make 8. Learners take the cards to their seats as work cards to write the sums (number sentences in their books). They copy the houses in their books with the dots. In their books lines like those on the cards are drawn by the teacher. So the learners must just draw the dots and write the number 8 on top.

School B

Grade 2 Doubling

Whole class- Teacher asks what is the double of 8 and asks a learner to show on the number line how to double 8. The learners start at the number 8 and count 8 more. Teacher repeats this and asks the learners to count out loud so that other learners can also hear. Teacher explains that that is how you do doubling.

Teacher writes sums on the board and asks the learners to make the sum with dienes blocks to show the number and answer. 10 + 2 = 1 ten block and 2 loose dienes blocks. The work on the board is graded to 3 groups. Bottom, middle and top. Teacher asks one learner per sum to come to the front and show the sum using the dienes blocks.

Bottom group: Teacher then asks the learners to come to the mat (the owl group). Teacher uses blue books to keep the learners busy. She explains the blue book work to the learners.

Teacher asks one learner on the mat to make the number 41 with the dienes blocks. The learner takes one ten and four 1's and says that's 41. The teacher then writes the number 41 on a big page and the learner immediately realises that there must be 4 tens and 1 one (because of the order of the numbers). Teacher then writes tens and units on the page and tells the learners to place the tens under the tens and the units under the units. Thereafter, the learner must draw the picture of the dienes blocks. Teacher then says 41 plus 22 and the learners pack out 2 tens and 2 ones and draw the number/dienes that make 22 next to those that make 41. The teacher then asks what is the answer. Teacher makes learners aware of counting tens first and then adding the ones. Learners are then told to do the work in their blue books.

Teacher takes a second group on the mat (16 learners).

This group is told that they are not going to use counters.

The teacher writes a number sentence on the page 44 + 23 and asks the learners what to do. She asks the learners are encouraged to break up the number. Teacher asks questions. What is 44? The learners answer: 4 tens and 4 ones. The teacher then asks: what is 4 tens and the learners answer 4. The teacher then asks again what the number is and the learners answer 44 (forty four). The teacher then explains that it is not a four but forty. The learners then break up the number into tens and ones.

School B

Grade 3

Learners work in their books using their number grids. Teacher has her big number grid or chart infront. Learners count in 1s starting at number 6 and are told to stop and count back from the number 45. Teacher then says lets count in 2’s starting from a certain number. Learners count and they are told to count in 3s starting at the number 3. They make a mistake and include the number 14. Teacher tells them to stop and count again. Teacher tells the learners if they are counting in tens backwards, they are going up and if they are counting forward, they go down.

Teacher does mental maths with the whole class. Teacher asks how many days are there in a week, month, year, in two years. Teacher asks how many months are there in one and a half year and asks the learners to explain how they counted. Teacher asks how many minutes in 1 hour, 1 and a half hours and asks the learners to explain how they get to their answers every time.

Teacher has flashcards with numbers on and a semi-concrete representation of the 100 dienes block. Teacher asks how many blocks are in the 100 dienes block. Learners answer 100. Teacher also has a card with ten blocks drawn, representing the 10 block. Teacher then asks the learners to count as she places the 100 block on the board. Teacher places 3 100 blocks and the learnrs count till 300 in 100s. Then the teacher puts the 10 blocks on the board and asks how many of these will she need to make 100. Learners answer 10 and teacher puts ten 10 blocks on the board and learners count in 10s and reach 100. Teacher takes away 1 ten and asks the learners how many there are, the learners answer 90. The learners then count everything starting at 100. They count 100. 200. 300, 310, 320 up till 390. Teacher then makes the learners aware again that 10 10 blocks make 100. She says, so 10 10 blocks are the same as 100 blocks.

Teacher then introduces the ones and puts 5 ones on the board. Learners count the one in ones. Teacher takes away 1 100 block and leaves 2 100 blocks, 4 10 blocks and 5 ones blocks. She asks the learners how many 100s? what number is that and the learners answer 200. Teache puts the numbers next to the blocks.

Teacher then writes a number on the board 425 and underlines one digit at a time and asks the learner what the value of the digit it is. What the number represented by the digit is. The learners answer correctly all the time. Teacher verbally gives learners +10 number sentences eg 67+10 and the learners put up their hands to answer. Teacher the hands out worksheets for the learners to do at their tables.Teacher hands out 2 worksheets per learner and explains explicitly what needs to be done. She reads and explains each question.

**Group activity**

**7 learners**

Teacher calls a group to the mat and asks them to bring their pencils. Each learner is give a b lank page. Teacher puts some tens and ones blocks on the mat and tells the learners to take a few. Teacher picks up 1 ten block and ask the learners how many 1 blocks there are in a ten block. The learners answer 10. The teacher then writes a number on the board and asks the learners to make the number with their base ten blocks on their pages. She then asks how many tens are in the number and how many ones. She then asks the learners to +10 and asks the learners what happens. Which block must they add? Learners answer 1 ten block. Ask s if the units stay the same or change. Learners say the unit do not change. Teacher hands out number sentence strips to make the number sentence with the blocks. The number sentences are all +10

**Second group**

**12 learners**

Learners get number sentence strips with minus (-) sign or symbol. Teacher explains that we take away 10. Learners do the sums on a white page with the blocks and write the sums and pass the strip on when done writing and working out the sum.