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A grade 7 teacher's selection and use of contexts in the learning support materials in order to promote understanding of the concept of variable among learners

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CHAPTER ONE: Research problem and critical questions

1.1 Background

Mathematics has been perceived over the years by the majority of people as a subject that is generally difficult to understand and hence to learn. Barbeau (1990) puts it more aptly by saying: “Probably no area of human activity is afflicted as mathematics with a gap between the public perception of its nature and what its practitioners believe it to be (cited in Picker and Berry, 2001:65). Efforts to close this gap have resulted in innumerable explorations and researches on how to bring access of the subject to the broader public. The South African mathematics curriculum has opted for the adoption of the selection and use of contexts as one of the approaches in the teaching and learning of the subject. The contexts that are selected and used are however conduits for access to the intended mathematics and the means by which the access is to be actuated are through learning support materials, teachers or both. It is therefore imperative to investigate how this is actuated.

1.2 Statement of purpose

There is little known about how teachers use materials to support teaching for understanding of mathematics and of specific mathematical concepts in the context of mathematics teaching in South Africa. This study is an exploration of the ways in which a Grade 7 teacher selects contexts in the learning support materials or in any other source for use in order to promote understanding of the concept of variable among learners.

1.3 Rationale for the research

My experience of nearly twenty years of teaching mathematics at high school has been that learners have a better understanding of arithmetic numbers than variables. This disjunction continues to persist despite extensive research that has been done in algebra and therefore further investigation is necessary.

1.3.1 Location of the concept of variable in the mathematics curriculum

The new South African curriculum in the form of *Learning Outcome 2: Patterns, Functions and Algebra* (LO2) of the Revised National Curriculum Statement (RNCS) requires that contexts "should be selected in which the learner can use algebraic language and skill to describe patterns, and relationships in a way that builds awareness of other Learning Areas, as well as human rights, social, economic, cultural, political and environmental issues. For example, the learner should be able to:

- investigate geometric patterns in art and architecture;
- study symmetrical patterns that occur in nature;
- understand formulae used to calculate pensions (payouts) and medical aid rates;
- understand and use formulae for calculating quantities encountered in Natural Sciences (e.g. air pressure, resistance, voltage);
- consider how graphs in the media can be manipulated to misrepresent trends and patterns; and
- use mathematical models to represent relationships within an ecosystem (Department of Education, 2002, p. 63).

In particular, it is in the Grade seven assessment standards of LO2 that the learners are expected to represent and use relationships with *variables* (DoE, 2002, p. 74). The learners that are in grade 7 in 2006 will be the first group in the implementation of the RNCS that will be affected by this assessment standard.

1.3.2 The selection and use of context in the mathematics curriculum

The first four Learning Outcomes of mathematics in the RNCS (Grades 7 – 9) viz. number, operations and relationships; patterns, functions and algebra; space and shape (geometry) and measurement are characterised by a statement that leads with the words: "Contexts should be selected…." (Department of Education, 2002: 62 – 65). Although the words are conspicuous with their absence in Learning Outcome 5: *Data Handling*, the very data that have to be handled are contextual. The use of contexts in the curriculum, especially relating to their use in mathematics, is fairly a recent practice in South Africa and is one of the significant features of outcome based education (OBE), and it therefore

becomes imperative to investigate how teachers in practicing environments in the schools deal with the issue. This study, actuated by the compulsion to investigate this matter, was therefore undertaken. The study explores how a teacher, faced with the expectation of using contexts in the teaching and learning of mathematics, would selects the contexts in the learning support materials in order to promote the understanding of the key concept of *variable* amongst learners.

There can be no doubt that the implementation of the new curriculum in the form of the RNCS will bring with it new challenges and innovations that should not only be identified but documented for either further research or replication. This study was therefore seeking to get an in-depth exploration of how a teacher overcomes the new challenges as well as to record any innovations that the teacher comes up with in the implementation of the new curriculum.

1.4 Research questions

The following critical questions guided this exploration:

- What contexts are selected by Grade 7 teacher to promote understanding of the concept of variable and why?
- How are the selected contexts intended to be used by the teacher in order to promote the understanding of the concept of variable?
- To what extent do the contexts selected for use have the potential to promote the understanding of the concept of variable?

This report utilises the theoretical framework that is elaborated on in the next chapter. The chapter also includes the literature reviewed for the study. The research methodology that was pursued is contained in Chapter 3 in which validity, reliability and ethical considerations as well as the research design for the study are discussed. The collection of data and the approach to data analysis are also part of this chapter. Data analysis forms Chapter 4 and in it the materials that were made available and used by the teacher are analysed. The analysis of the teacher interview and the summary of the findings conclude this chapter. The findings of the study are discussed in Chapter 5 and this is followed by the conclusion in chapter 6.

CHAPTER TWO: Theoretical Framework and Literature Review

2.1 Theoretical Framework

This study draws on the socio-cultural theories that portray understanding as developing through interpersonal activity. It is underpinned by the notion that understanding of a concept presupposes and is presupposed by its formation.

According to Crook (2003) the socio-cultural approach recognises mediation as its central concept in learning and teaching. The emphasis on mediation gives rise three themes, viz. that:

- cognition is more than the repertoires of circumscribed and private processes but an activity of integrated functional systems;
- cognitive acquisitions are initially situated and tied to contexts; and
- cognition is a profoundly social phenomenon.

The adoption of a socio-cultural framework is largely informed by the importance of the mediatory roles assumed by teachers and learning support materials in the social interaction that take place in order to facilitate learners' understanding.

2.1.1 Classroom participation

Remillard (2005) provides a framework for characterising and studying teachers' interactions with curriculum materials and states that: "…the teacher-curriculum relationship is intertwined with other teaching practices, is dependent on the particular teacher and curriculum, and is situated in a specific context" (p. 212). She identifies four theoretical perspectives on the conceptions of curriculum use, viz. following or subverting the text, drawing on the text, interpreting the text as well as participating with the text. With the first three perspectives being influenced by theories of positivism and/or interpretivism, it is the last one, participating with the text, which I used in the study as it draws on the socio-cultural theory. Curriculum materials are considered, with

this perspective, as artefacts, tools or products of a socio-cultural evolution, with teachers' role viewed as collaborators with the curriculum materials with the purpose of designing the enactment of curriculum and this teacher-curriculum relationship is described as participatory, influenced by both the teacher and curriculum. Participation is contrasted with both positivism, which holds the view that there exists a single reality, and interpretivism, which holds the view that reality is relative and constructed by the individual. The participation perspective argues that there are many realities out there and whatever individuals may 'possess' is only useful when the individual is involved in activities with others, i.e. participating.

Remillard (2005, p. 235) further offers a framework of the components of the teacher-curriculum relationship in which this participatory relationship is described in terms of the planned and enacted curricula as well as the contexts and the students. I drew very heavily on this framework as well as an adaptation of the situated perspective which explores learning as a community of practice and is described in terms of legitimate peripheral participation (LPP). LPP is the descriptor of engagement in a social practice in which increased participation of newcomers (apprentices) in ongoing practice shape their gradual transformation into old-timers (masters) (Lave and Wenger, 1991; and Lave, 1993). The framework that I used was therefore an adaptation of Remillard's components of teacher-curriculum relationships framework together with Lave and Wenger's situated perspective. For the purposes of this report the curriculum is placed as part of the socio-cultural context and viewing the teacher is viewed as playing the role of an old-timer while learners are newcomers to be apprenticed into an envisaged form of participation. The proposed framework therefore takes the form of a "classroom participation" model which is captured in the accompanying Figure 1.

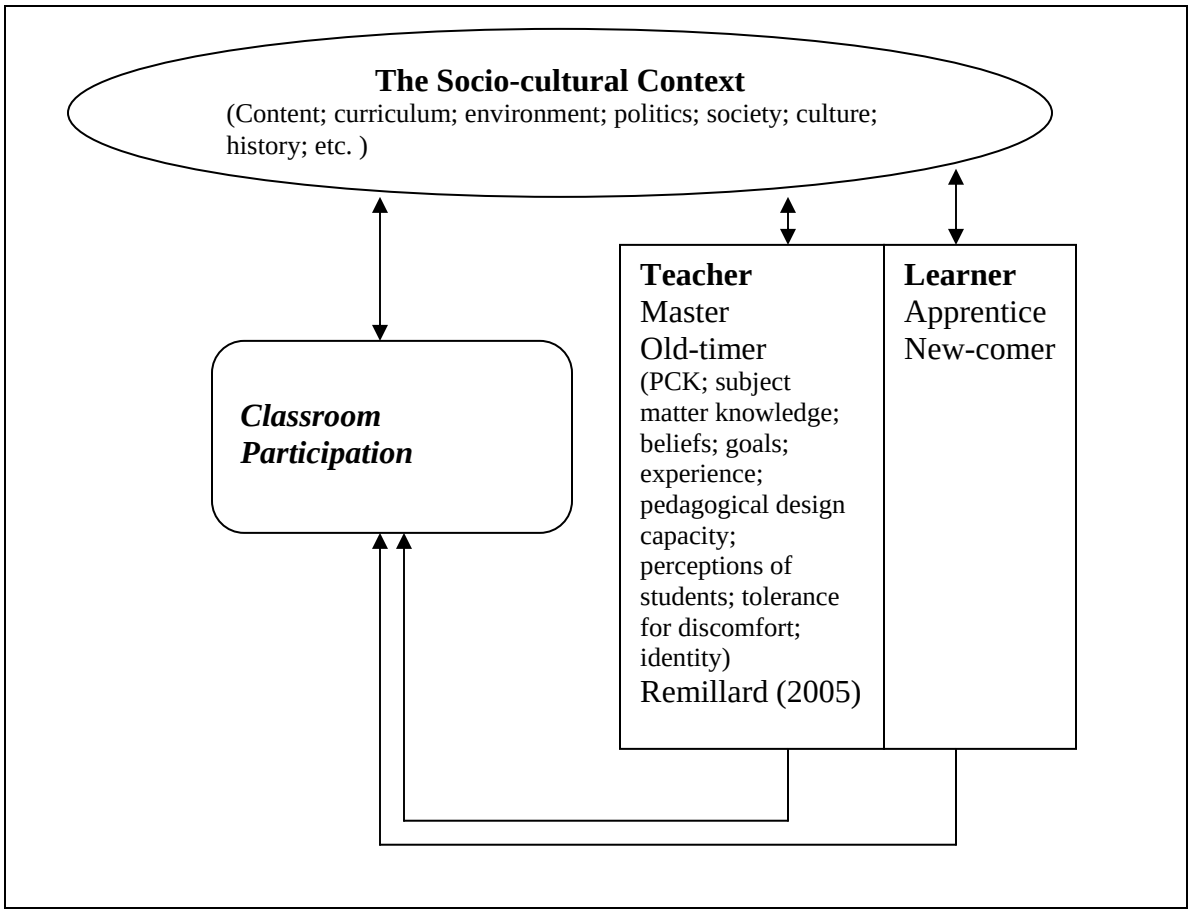


Figure 1: *The Classroom Participation Model*

The teacher in this model is viewed as old-timer whose role is to 'apprentice' the learners who are viewed as new-comers in terms their involvement with the new concept called *variable*. The learners are expected to 'participate' in the classrooms, where the concept of variable is concerned, as far as what is expected of them in the RNCS. The participation described here is by no means the same as the one described in Lave and Wenger's LPP as it should be acknowledged that classrooms cannot be automatically seen communities of practice. This participation is not viewed in terms that are beyond the selection of materials by the teacher in promoting the understanding and use of the concept of variable by Grade 7 learners. It is rational to suggest that whatever contexts that the teacher has selected in order to 'apprentice' the learner for 'participation' will have some effect not only on the 'apprenticeship' of the learner but the learners' manner

and level of 'participation' as determined by the learners' understanding of the concept of *variable*.

2.1.2 The understanding of a mathematical concept

The RNCS states that mathematical ideas and concepts are build on one another to create a coherent structure (DoE, 2002, 4) while White and Gunstone (1992) indicate that in order to understand a concept some information about that concept must be in existence in some way or another in the experience of the participant. The understanding of a concept presupposes and is presupposed by its formation. It is important in looking into the promotion of the understanding of a mathematical concept that the understanding of how the concept is formed be also explored.

Skemp (1981) indicates that the initial stages of concept formation is characterised by the bringing of past experiences to the present situation by first classifying previous experiences and then fitting the present experience into one of these classes. He states that the formation of a concept requires a number of experiences which have something in common while at the same time highlighting the importance of contrast and of non-examples which make the similarity between members of a particular classification more noticeable. He further identifies primary concepts as those that are derived from sensory and motor experiences whereas secondary concepts are pointed out as those that are abstracted from other concepts. The conceptual hierarchy and the order between concepts are presupposed by concepts that have already being formed. The successive experiencing of certain common invariant properties, C_1, C_2, C_3, … are eventually abstracted as sub-concept C C^a such that any further experience C_n is recognised as C^a. The sub-concepts C^a, C^b, C^c, … are further abstracted into the more abstract secondary concept C such that any first time experience of an object will be recognised as a member of this class and where the invariant properties which characterise the primary concepts and sub-concepts become

more functional and less perceptual. The following therefore captures an adaptation of Skemp's illustration of the levels of the formation of a concept:

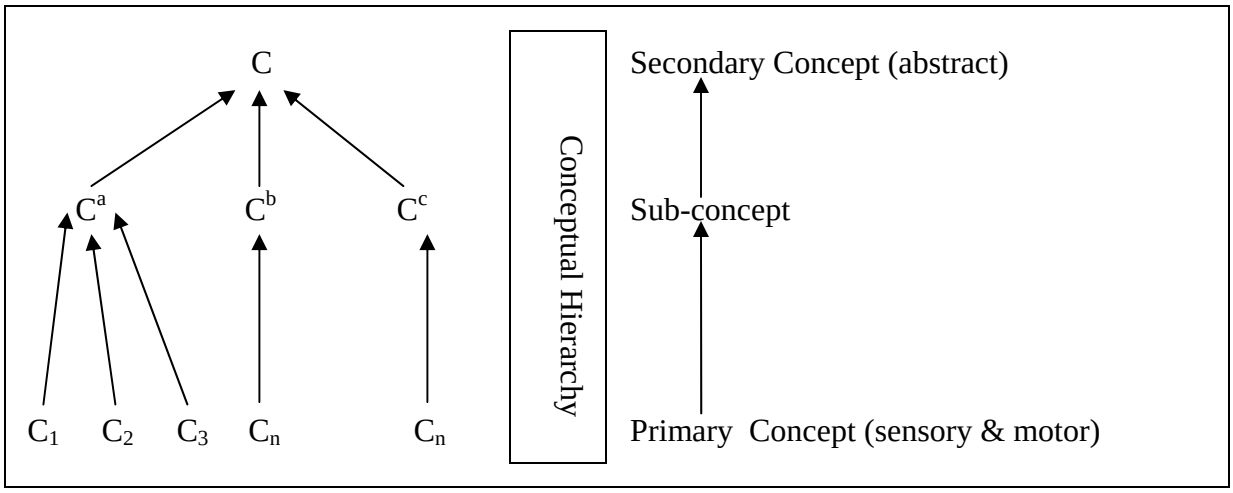


Figure 2: *Levels of the formation of a concept*

Skemp further puts forward two principles for the formation of concepts:

- '… concepts of a higher order than those which a person already has cannot be communicated to him by a definition, but only by collecting together, for him to experience, suitable examples' (Skemp, 1981, p. 82)
- 'since in mathematics these examples are almost invariably other concepts, it must first be assumed that these are already formed in the mind of the learner' (Skemp, 1981, p. 83)

With this perspective, a definition is seen as a way of adding precision to the boundaries of a formed concept as well as stating explicitly its relation to other concepts. In choosing the suitable collection of examples, the latter should be alike in the ways which are to be abstracted and otherwise they must be different enough such that the properties irrelevant to the particular concept can cancel out or fail to summate. The irrelevant properties which are referred to as noise are regarded as necessary for concept formation. Low noise is considered to be desirable in the early stages of concept formation in order to facilitate its clear embodiment while increased noise encouraged for more strongly established concepts in order to lead to abstract conceptualisation.

The role of the teacher in the implementation of any curriculum can never be overemphasised. It is recognised that factors, other than the curriculum, such as teacher cognition, personal experience, the environment (the school, policy, the district, etc.) have an impact on teacher actions. Research has shown that teachers have theories and belief systems that influence their perceptions, plans and actions in the classroom (Carpenter & Fennema, 1991). Putman, Heaton, Prawat & Remillard (1992), Thompson (1989) and Nespor (1987) have all indicated that teachers' cognitions influence their instructional practices. Pearce and Loyd (1987) say that teachers' actions are directly influenced by their previous experiences while Garett (1978) and Muskin (1990) indicate that the environment has an impact on the teacher's actions.

It can be expected that teacher knowledge will play a crucial role in determining what is selected as well as how whatever has been selected will be used. This brings to the fore the teacher's pedagogical content of knowledge (PCK). PCK is described as the knowledge of a subject that enables the knower to teach the subject. According to Ball, Lubienski and Mewborn (2001,p. 453), PCK "involves bundles of understanding that combine knowledge of mathematics, of students and of pedagogy….Those bundles offer a crucial resource for teaching mathematics because they can help the teacher to anticipate what students might have trouble learning and to have ready alternative models or explanations to mediate those difficulties". The question that can be asked is to what extent will the teacher's PCK determine his/her selections of content and context?

The focus of my study is therefore to explore what role does the teacher play, what does she draw on and how does she go about in her endeavour to participate fully in the classroom activities and hence be in a position to give access to students' understanding of the concept of variable. This will be done by placing special attention on the teacher's interaction with the contexts in the learning support material (LSM) or any other sources, but not overlooking the implicit effects of other socio-cultural factors. The issue of language and access to resources play a critical role in the teaching and learning and in South Africa in particular, these impact negatively in the majority of learners.

2.2 Literature Review

2.2.1 The Concept of Variable

Wijers and van Reeuwijk (2004) suggest that the introduction of the concept of variable at a lower level such as grade 7, should be in such way that learners can operate with it at "a concrete and informal level" (p.81). At this stage of learner development it could be regarded as 'safe' to view algebra as *generalised arithmetic* because the variables used in traditional school algebra will "always stand for numbers" (Lin & Kaput, 2004, p. 51). This approach however was shown to bring unexpected observations as reported in the study by Booth (1984) that a number of error patterns by learners were prevalent and it was suggested that these error patterns could be eliminated by appropriate teaching.

Cangelosi (1996) contends that conceptual errors or mathematical treatises that conflict with what teachers want their learners to learn can hinder teaching and learning. Using the example of the definition of a variable, found in many textbooks, as "a letter that stands for a number" he cautions that such restrictive definitions preclude connections of mathematics with real-life situations and adds that:

> If you take that definition literally – and I assume you want your students to take mathematical definitions literally – then interest rates, age, speed, time, shape, set, location, length, number of, angle, angle measure, and all other variables we deal with in problem solving are not variables. These texts say that a variable is a *letter* – not what the letter stands for, but the letter itself! (Cangelosi, 1996, p. 178)

The definition of a variable has appeared in the literature as being, amongst others, 'a letter that is used in formulas and mathematical expressions' (Abdelnoor, 1979), 'where letters appear in a number sentence (equation) assuming different values which make the number sentence true' (Dekker and Visser, 1984), and 'a letter or other symbol that is used to represent any number in a specified set' (Cobran, 1982). Although Dlamini (2003) defines a variable as any letter that represents more than one solution set, it is the definition in Cangelosi (1996) that captures the substance of what this study will draw heavily on. He states that a variable is a quantity, quality or characteristic that can assume

more than one value. It is important to note that this definition does not restrict the variable to the use of a letter and in fact highlights the implicit link between the variable with contexts as quantity, quality and characteristic which are all descriptions of everyday experiences.

The use of letters to stand for variables has led to a lot of confusion such that letters that are used to stand for unknowns in close-ended equations are referred to as variables even though, taking into consideration the literal meaning of the word, the values that are to be assumed by these letters are not variable themselves but will stand for only one value per given equation.

2.2.2 The Use of Context

The use of context in an educational setting means a look at, first, the *learning environment* in which the different situations that learning takes place are taken into consideration as well as a look into the interpersonal dimensions of learning. Secondly, it is when looking at *a characteristic of a task presented to learners* by considering the words and pictures that help the learners' understanding of the task (Van den Heuvel-Panhuizen, 2005). The purpose of this study was therefore to find out what a teacher views as requisite or not requisite and to identify what the teacher views as hindrances or accessory in the promotion of the understanding of the concept of variable. This I believe would benefit learners, teachers, curriculum material developers, as well as researchers by providing information that may enhance learners' understanding of variables and concomitantly the learning of algebra.

In the study by Watson and Kelly (2005) in which contexts were used to explore the development of pre-Grade 1 to Grade 9, students' intuitive ideas of variation and for the upper levels of Grade 7 and Grade 9 their understanding of the concept of variable was explored. Due to the difficulties experienced by the students in the research, the researchers suggested that teachers and curriculum planners should include more contexts of an authentic social and scientific nature in the introduction of a topic such as data

handling, in which the concept of variable is applicable. Questions that arise out of findings such as these are that if more contexts are to be used, what kinds should they be and in what ways should they be used?

2.2.3 The concept of variable and context

The pursuit to use real life contexts in the teaching of variables, however, raises problems such as the one referred to as the "fruit salad algebra", where problems of explaining the addition of different terms in $2a + 3b$ where apples and bananas are respectively used to promote the understanding of the variables *a* and *b* arise (Wijers and van Reeuwijk, 2004, p.82). The role of the teacher in the selection of contexts is therefore critical in ensuring that the contexts are not going to lead to learners experiencing difficulties in the understanding of the concept of variable. Referring to a teaching approach that is based on the philosophy of a community of enquiry, Wijers and van Reeuwijk (2004) caution that:

> "….the intention is that students learn mathematics in a way that makes sense to them and evolves from their 'own' pre-formal knowledge. A consequence is that this may result in students using (temporary) mathematical actions which are not fully formed.'' (p. 83)

It is therefore imperative that the understanding of the concept of variable to the learners in grade 7 be fully formed in order to enhance their learning of algebra. This should be done in consideration of the learners' prior knowledge and also by anticipating the possible difficulties they may encounter in this process as well as looking into possible misconceptions that the learners may form.

Blanton and Kaput (2005) identify generalised arithmetic and functional thinking as the two forms of algebraic reasoning that are more common in the elementary grades which are the equivalent levels that our South African grade 7 learners are at. The other two forms are modelling as a domain for expressing and formalising generalisations as well as generalising about mathematical systems abstracted from computations and relations. Research has shown that focussing on both the generalised arithmetic and functional thinking dispels the developmental constraints that were previously imposed on the learners in as far as algebraic reasoning is concerned (Carpenter & Franke, 2001;

Carpenter, Franke & Levi, 2003; Carraher & Earnest, 2003; Carraher, Brizuela & Schliemann, 2000; Falkner, Levi & Carpenter, 1999, Kieran, 1992; Mason, 1996; Schifter, 1999; Blanton and Kaput, 2003, 2004, 2005). Generalised arithmetic refers to the use of arithmetic as a domain for expressing and formalising generalisations whereas by functional thinking it is meant the generalisation of numerical patterns in the description of functional relationships, for instance, the generalisations about the sum of consecutive numbers. Based on the theory that prior knowledge is essential for the understanding of new concepts, in using generalised arithmetic and functional thinking, learners are afforded the link to which their understanding of the concept of variable can be constructed and hence the development of algebraic reasoning. It will be important therefore to find out to what extent are the teachers' selections concomitant to what theory suggests. It will be of importance to account for whatever prevalent differences.

2.2.4 Implementation of a new curriculum

In terms of what teachers do in implementing a new curriculum, the study by Haimes (1996) found that teacher's previous experiences overshadowed the intended curriculum in terms of their pedagogical practices. It was revealed that in the implementation of a new curriculum that 65% of teachers surveyed reported using teacher-centred pedagogical practices when introducing new topics in the class (Haimes, 1991). Access to more meaningful learning support materials and in-service training was recommended for teachers in order to overcome teachers' previous experiences in order to enhance the impact of the new curriculum on teachers. Ben-Perez (1990) puts forward the two phases of curriculum development as firstly the conceptualisation of curricular plans and writing them as resources for teachers and secondly the alteration, adaptation and/or translation of what is offered in the textbook by the teachers in order to make them appropriate for their students. It was this second phase that formed the focus of my study and hence the selection of the LSM or any other sources with particular interest on what contexts were chosen and why they were selected was explored.

The paper by van Etten and Smit (2005) reports on the challenges that are facing developers of the mathematics learning materials in order to meet the criteria set in the in the Revised National Curriculum Statement, mainly those that are associated with the requirement for use of contexts. If the publishers are faced with such kinds of problems, what kinds of problems are teachers facing in their practices in the usage of contexts? It will be interesting then to find out what challenges the teachers are faced with in their endeavour to make the learners meet the assessment standard regarding variables in accordance with the RNCS. Etten and Smit (2005) argue that the Realistic Mathematics Education (RME), developed in Netherlands, offers an approach that enhances the realisation of the learning outcomes of the RNCS in the South African education. The approach includes using a process of 'guided reinvention' and 'progressive mathematisation' in which the guidance from the teacher who has to develop directions for learners is essential. The teacher has to steer the learners away from paths that lead to nowhere and bringing in convergence in terms of the discourse that is prevailing in mathematics. Mathematisation – defined as the translation of contexts into mathematics – of the subject matter should be experientially real for the learners and is one of the elements in the 'scheme of learning mathematics in a context' that are identified in the Van Etten & Smit paper. The others elements are:

- Doing maths: finding mathematical solution through mathematical activities
- Interpret: translating the mathematical solution to the context
- Verify: testing whether the solution fits into context

(Van Etten & Smit, 2005: p.58)

The notion of mathematisation forms one of the tools of analysis in this study as I regard it as one of the most important aspect in the implementation of the new curriculum in South Africa which emphasises the use of contexts.

2.2.5 The selection and use of curriculum materials by teachers

Remillard (2005) contends that there is a need for open and active engagement in teachers' participation with new curriculum materials because this will benefit teachers as they engage in an interaction with others. This study was therefore undertaken in recognition of such a need and as a consequence focused on exploring on how a teacher interacted with the learning support materials at her disposal in the implementation of the new curriculum where the use of context is also emphasised. This was done by paying attention to what informs the teacher's selection and use of the materials when the purpose is to promote the understanding of the concept of variable amongst her learners.

While Remillard (2005), in looking at the participatory relationships between the teacher and the curriculum materials, highlights the local and global contexts brought about by both the teacher and the materials, this study focused on the contexts in the learning support materials that were selected and used by the teacher for the participation. She identified a number of studies that found that teaching and social contexts influenced the way teachers engaged with, read, and used mathematics curriculum materials (Remillard, 2005: 238). This study is concerned with what contexts in the learning support materials inform the teacher's selections.

In terms of the selection of curriculum materials by teachers for use in the classrooms Stoffels (2005) identified curriculum texts as steering content selection and concomitantly being viewed in an authoritative manner by teachers. Some of the factors that informed the teacher's selections were identified as the overwhelming administrative burdens of the implementation of a new curriculum, the unpreparedness of the teachers in the pedagogical shifts of the curriculum as well as the departmental policies rationalisation and redeployment of teachers. It had to be acknowledged that the factors identified in Stoffels's study as having had the influence in the teachers' selection were still relevant for the teacher in this study and it was therefore prudent to find out what would inform a teacher's selection when contexts are expected to be used for the promotion of the understanding of the concept of variable amongst learners.

Research has been done on teachers' use and learning from curriculum materials that are designed to support teacher learning (Collopy, 2003) and in her study she reports that some support was provided for the conjecture that curriculum materials designed to convey subject matter and pedagogical content knowledge to teachers may facilitate teacher learning, but also reports on the limitations of curriculum materials on the professional development of the teachers in that they do not always support teacher learning.

The selection of contexts by the teacher may either enhance or hinder the promotion of understanding of the concept of variable. It therefore becomes critical to find out which contexts – and why – are to the teacher necessary to select in order to achieve this. Are the contexts of an authentic social nature? Are they closest to learners' everyday experiences? The contexts selected have to be used also in a way that promotes understanding of the concept and it is therefore imperative to investigate how the contexts are used by the teacher in order to promote learners' understanding of the concept.

It can be expected that contexts that are selected as well as how they are used by the teacher may or may not have an impact on the extent to which the promotion of understanding of the concept of variable amongst learners may be achieved. The question – to what extent do the contexts that are selected for use have the potential to promote understanding of the concept of variable? – therefore becomes critical. However factors such as the implementation of the new curriculum, teacher's beliefs together with the environment in which the teacher is based may have an impact on the teacher's selection as well as how she uses the contexts.

CHAPTER THREE: Research methodology and design

3.1 Introduction

The methodological approach that I adopted for this study is elaborated on in this chapter where justification for it is also provided. I also elaborate on ethical considerations that arose with respect to the study and the steps I undertook to address them. The data collection process is described with details pertaining to the procedure I undertook to realise the process.

3.2 Methodological approach

The research approach that I pursued was a case study. According to Opie (2004) a case study is an in-depth study of a single instance, in an enclosed system where certain features of social behaviour or activities in particular settings together with other factors influence the situation. This qualitative approach is informed by the exploratory and interpretative nature of the study. Creswell (1994) cited in Leedy (1997) describes a qualitative study as an "inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants and conducted in a natural setting." The study was not intended to look for the generalisation of the results but to highlight, through in-depth exploration, the practical situations that a teacher in an environment finds herself in, in her quest to deliver on what the curriculum is expecting from her. Opie's (2004) essential features of a case study were met in this study due to the fact that a systematic collection of data was employed and real people in real situations were involved. My familiarity with the teaching environment as a teacher of more than twenty years is self-evident and with the aim of the study being to provide a picture of what a teacher in a particular setting undertakes to select contexts for use in order to promote learners' understanding the approach adopted in the study is warranted.

The research procedure that I used was the administration of a questionnaire as entry point from which part of the data that was gathered was to be used to elicit questions that

were subsequently to be used in the interview to be conducted at a later date. Classroom observation was not done for this study in the endeavour of aiming to focus on what and how the teacher selected contexts for use in the classroom, the major part of which takes place outside the classroom in terms of the teacher's preparations. It was therefore essential for this study to keep the focus on the activities prior to the teacher's classroom practices. The questionnaire, which is the most widely used procedure for obtaining information and in which questions can be written for specific purposes, was used to provide some information on the teacher's selection activities (Opie, 2004). Interviews, on the other hand, were conducted as they not only provide qualitative and in-depth data but they provide information as to why whatever is happening is taking place. They encourage the respondents to develop own ideas and allow the latter to say what they think and the respondents do so in greater richness and spontaneity (Oppenheim, 1992, p.82).

3.3 Validity and Reliability

Using the instrument of interviews however raises the inherent problem of bias and hence impacting on the validity of any study. Bias is defined by Lansing et al. (1961) cited in Cohen, Manion and Morrison (2000) as overstating or understating the true value or attribute. Identifying sources of bias as the characteristics of the researcher and the participant as well as the substantive content of the questions, Cohen et al. suggest the minimisation of the amount of bias as the most pragmatic manner of enhancement of validity. Validity is described as the degree to which a method, a test or a research tool actually measures what it is supposed to measure such that a relationship between claim and results of the data-gathering process can be made (Wellington, 2000 cited in Opie, 2004). Apart from the different data-gathering processes used in the study which included the questionnaire, the analysis of the only textbook that the teacher had availed and indicated she was using in class as well as the analysis of materials that she had actually used in her class, the use of two semi-structured interviews allowed for more flexibility on the part of both the researcher and the respondent giving credence to the issue of the validity of the study.

Reliability, on the other hand, is put as the consistency in results across a range of settings for the administered method, test or research tool when used by a range of researchers (Wellington, 2000 cited in Opie, 2004). Due to the uniqueness and the idiosyncrasy of the study that was undertaken here the replication such qualitative research is highly unlikely (Pressle, 1993 cited in Cohen et al., 2000). In order to address reliability issues in this study it was critical that accurate descriptions of the processes that were followed were done and this was accomplished by ensuring that only the data that was collected was that which was made available by the teacher and was subsequently kept in safe place for availability subject to the approval of the respondent.

3.4 Ethical considerations

McMillan and Schumacher (1993) maintain that it is imperative for researchers to obtain permission to enter any particular field and also ensure the confidentiality and anonymity of the participants, thus encouraging the latter's free choice of participation. This required a full description to the participants of how the data that was collected was to be used by the researcher. The following ethical guidelines were therefore pursued:

- Permission was sought from the Gauteng Department of Education and the University of the Witwatersrand for conducting the research, from the head of the school for the use of the school and from the teacher to participate in the study. (Appendices 7 and 8)
- Permission was sought to digitally record the participant's responses in the form of interviews. (Appendix 6)
- The confidentiality and anonymity of participant was assured by guaranteeing to withhold the real name and location of the participant in the research. It was also guaranteed that no data will be used against the participant's will and all the information regarding the study will be kept in safety and in secret. (Appendices 3 and 6)

- Consent letters were sent to the principal and participating teacher and it was only after obtaining permission from them that further steps regarding the study were taken. (Appendices 3 and 6)

To address the ethical issues raised above I sought permission from the University of the Witwatersrand's Human Research Ethics Committee and permission was granted subject to noting the following two issues: 1) using pseudonyms rather than subject names in the raw data and 2) anonymity due to sample size cannot be completely maintained. The first issue was addressed by using the use of pseudonym for the teacher and the second issue was dealt with by not revealing the exact location where the study was conducted. The Gauteng Department of Education (GDE) was also approached for permission to conduct the research at one of its schools. The requisite documentation together with the proposal for the research were submitted at the GDE head office and permission was also granted with the proviso that the permission letter be submitted to the District Office where the school is located and that both the principal and school governing body be approached for the permission. I therefore approached the principal for the permission to conduct the research and this was granted on condition that I do not conduct the research during the teacher's contact time with the learners and I was informed telephonically after almost ten days.

3.5 The Design of the Study

3.5.1 The Context

The research was conducted at Siyabonga[1] Primary School, a former Model C school in Gauteng, which is situated near a township with the result that almost the entire learner population is Black. The teacher population in the school covers a major spectrum of the South African racial groups in that Blacks, Whites, Coloureds and Indians are represented. The facilities in the school are way above those of a typical township school with the school fees being charged per learner being more than five times what is averagely charged in the neighbouring township schools.

[1] pseudonym

3.5.2 Biographical Details of the Teacher

The study involved Bongi[2], an enthusiastic and vibrant grade 7 mathematics teacher, whose acquaintance I had the pleasure of having before the start of the research. The teacher has done mathematics up to Grade 12 and proceeded to obtain a diploma in teaching specializing in Mathematics and Physical Education. She has been teaching mathematics in Grade 6 for the past three years and this was her first year of teaching the Grade 7's. She loves teaching the subject and finds it interesting. She believes that it is important to focus on multiplication and that learners have to be drilled in this operation. Having been taught by 'brilliant' teachers, the teacher felt that their insistence on the 'learners knowing their tables' was critical. She also believes that communication between teachers of mathematics in the lower and upper classes enhances the teaching of the subject because the lower class teachers 'lay the foundation' for the learners so that they should cope with work in the upper classes. She finds the learners to be lacking in the basic concepts and identified them to be 'weak' in fraction. She believes that the new RNCS approach is not promoting the understanding of mathematics as the learners are given tasks that they do at home and 'get everything right' but in class 'they get naught'.

Bongi had attended inservice-training on the RNCS in 2005, the year in which she was teaching mathematics to the same learners in Grade 6, and found the training 'appropriate', however she felt that the standard of the learners did not match the level at which the curriculum was pitched. She had not attended any RNCS training in 2006. She indicated that planning is very important in preparation for a new topic or lesson. In particular, she found a textbook of 5 years ago as very helpful in her preparation as it 'outlined steps on how to go about' teaching the topics or lessons. She felt that the new books were lacking in the detail and actually preferred textbooks that 'show the steps'.

[2] pseudonym

3.6 Data Collection

I conducted interviews with the teacher for this research, as well as collected the materials or documents used by the teacher in the presentation of the concept of variable. An analysis on how the teacher went about in the selection of the contexts for the promotion of the understanding of the concept of variable was done by comparing what was available for the teacher to select from in terms of the textbooks and other materials that were at the teacher's disposal with what the teacher chose to use. Although I had initially foreseen it to be useful to compare the contexts used by two different teachers in two differing environments, namely the former Model C and the previously disadvantaged township school, I noted that the new curriculum, in pursuit of equitable access to learning opportunities, and in the effort to close the gap that existed in the past (or still exists) in the numerous kinds of settings that are prevalent in South African schools, opted for use of contexts in order to eliminate environmental factors accounting for the differences associated with the latter. The question that I asked is that if one looks at the different environments in terms of formerly advantaged vs. disadvantaged, what about rural vs. urban schools, school 1 vs. school 2 in the same environment and all other different ramifications possible for investigation. I therefore viewed an investigation as to how the different settings will influence the choice and/or use of the contexts in the teaching of the same concept not only inappropriate for this study but also being what can be regarded as a deviation from the intended curriculum. This study is, as a consequence, focussing on the activities of the teacher in the enactment of the curriculum, empowered by the curriculum through the use of contexts available to her, in order to promote the understanding of the concept of variable amongst her learners.

A qualitative method of data collection was employed in which insight into what the teacher's selection criteria was investigated (McMillan and Schumacher, 1993). Effort was also undertaken to capture the teacher's views on the concept of variable. As a researcher that was actively involved in the entire data collection process I undertook to exercise insightfulness, flexibility and responsiveness by utilising tacit knowledge in a meaningful way (Guba and Lincon, 1985). In anticipation of having had to conduct the study prior or post the teacher's presentation of the lesson(s) on variables, since the topic

would not have taken more than two to three sessions of presentation, the collection of data was, as an entry point, the administration of a questionnaire (see appendix A) together with materials that the teacher could avail to the researcher which the former was using in terms preparations for her lessons. This was followed by the initial interview with the teacher in which biographical details with regard to the teacher were explored. Finally the main interview with the teacher was conducted where insights from preliminary visits were used to develop the interview schedule.

Of the three styles of interviewing identified by Opie (2004), namely structured, semi-structured and unstructured interviews, I employed the semi-structured interview. With the structured interviews controlled by the interviewer, being the least flexible, following the researcher's predetermined agenda and generally very easy to analyse while the unstructured interviews are evenly controlled by the researcher and respondent, very flexible, often taking unpredictable directions leading to unexpected findings and having the likelihood of being difficult to analyse, my choice for the semi-structured interview was informed by its suitability for the study in terms of its main focus. The study was concentrating on the teacher's activities and therefore considerable control and direction of the interview was partly determined by the interviewee. With this style of interview it was possible to allow for more flexibility of the interview guided by what was coming under the discussions. The respondent was allowed to expand on her responses allowing room for deviations and change in the wording and the order of questions that were asked. Critically, the overall shape of the interview for this study was maintained as per focus on the particular aspects that were being pursued, preventing aimless ramblings that may otherwise had emerged in the interview. With this style of interview it was possible to do follow-up questions and probes and the respondent was allowed to have more latitude in terms of her responses. As an example, questions that appeared to have elicited unclear responses allowed both the researcher and the respondents offer examples to support or clarify the utterances. It was however necessary to take careful consideration of the phenomenon of the complexity of social meaning such that conclusions that were drawn from the acquired data required guarded and careful interpretations.

3.6.1 Data Collection Process

The teacher was a very willing participant in this research. She went out her way to give assurances that she was willing to provide whatever she could during the research. At the start of the research, the purpose of the research was explained to the teacher briefly and she was then asked to complete the consent letter. At this first meeting of the research, the teacher was also asked to complete a questionnaire which she was requested to be handed over at a later date convenient to her. On this occasion the teacher also willingly provided the researcher with one of the textbooks she was using for teaching her Grade 7 mathematics learners. The textbook was analysed in terms possible context in it available for the teacher for selection in terms of teaching the concept of variable. Both consent form and the questionnaire were duly returned about two days later.

The teacher identified Tuesdays between 12h00 and 13h00 as the days I could come to conduct the research. Of the five visits I undertook to the school, two were used for conducting the interviews. On both occasions, the teacher was thanked and appreciation for the teacher's willingness to be involved in the study was conveyed. She was also informed that the aim of the research was not to seek right or wrong answers and that she should feel free to ask questions. The first interview was preliminary such that mainly the teacher's biographical details, her views about mathematics and her work including her views about the mathematics materials at her disposal were explored. The second interview was more detailed, more in-depth and was conducted in minimal if no intimidatory circumstances. The teacher was free to air her views and was not badgered for any favourable responses. The interview was concluded with the teacher promising to provide further materials she had used or would use in teaching the concept of variable and also give an indication of the reasons for her selections.

3.7 Approach to Data Analysis

The models of analysing data in qualitative research are called typological, inductive, interpretative, political and polyvocal analyses. Typological analysis is described as “the division of everything that is observed into groups or categories on the basis of some rule or criterion in order to disaggregate the whole phenomenon under study” (Hatch, 2002, p. 152). Hatch (2002) further states that the typologies for categorising or grouping are generated from theory, common sense, and/or research objectives. It was imperative for the study, however, to take into consideration that the selection and use of whatever material in order to promote the understanding of the concept of variable would be highly dependent on the actions of the teacher and could therefore not be predetermined. This therefore called for an inductive form of analysis. By taking particular pieces of evidence in the form of the materials that were used by the teacher or were at the disposal of the teacher and also in the form of extracts from the interview I pulled together some information into meaningful wholes, searching for patterns of meanings so as to make general statements about the phenomena under investigation (Hatch, 2002: 161). With the semi-structured interview containing open-ended questions, the coding of data was therefore necessary (Sapsford and Jupp, 1996:166) as it is mandatory in inductive analysis.

By combining mainly the typological and inductive forms of analyses in my study and considering that the study was looking into the selection of contexts by the teacher as well as employing the theoretical framework that I had chosen, it became apparent that the interpretive and the political forms of analyses could not be avoided and hence they were also used in the data analysis. The first analysis that I undertook to do was analysis of the materials and secondly the analysis of the interview.

CHAPTER FOUR: Data Analysis

4.1 Introduction

In this chapter the materials that were availed by the teacher were analysed in terms of, firstly, the intended presentation of the concept of variable and secondly, their potential to promote the understanding of the concept of variable amongst the learners. The teacher's responses to the questionnaire as well as data collected in the interviews were also analysed.

4.2 Analysis of the materials made available by the teacher

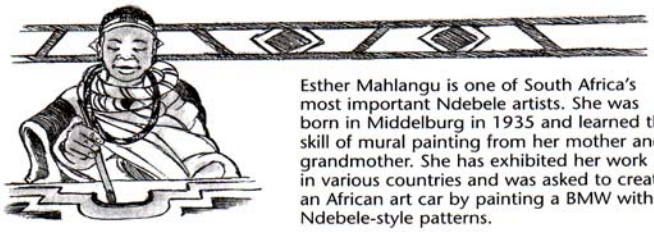
Although Bongi indicated that the she used several sources of materials for her teaching the researcher could only gain access to only one textbook that the teacher happened to have in her possession on one of the days of the researcher's visits. The textbook was designed in a manner that elucidated an inclination that could be interpreted to be that of alignment with the intended curriculum as stipulated in the RNCS. The textbook is arranged into four broad themes in the form of modules 1 to 4 which are respectively named "*Mind your own business*", "*SA 4 ME*", "*Plant a tree*" and "*R U OK*?" (Yule , Du Preez and Omar, 2005). The chapters are arranged under *Units* which are sub-divided into *Activities* which are captured in the form of specified topics and the intended Learning Outcome is indicated alongside the topic. Learning Outcome 2 of patterns, functions and algebra is found in units 1.2, 1.6, 2.2, 2.6, 3.2; 3.6, 4.2 and 4.6 in the respective modules. The majority of the presentations are typified by the use of contexts in their designs. Conspicuous by their absence in the materials are clear stipulated procedures or rules that had been the trade mark of textbooks of the past in which steps on how the learners had to go about doing the mathematics were prevalent. For example, one of the activities that learners had to engage with is captured under the topic *"Look at patterns in physical things"* where patterns in paving, tiling, linen, wood carvings etc. are highlighted for the learners and a short story of Esther Mahlangu, a Ndebele artist, is also stated. Learners are asked in this activity to list patterns that they had observed at their homes, school and their neighbourhood. This is followed by an activity for learners to tessellate ten 2cm by 2cm with ten 2cm by 3cm rectangles as shown in figure 4.1.

Unit 1.2 Activity 1	Look at patterns in physical things	Learning Outcome 2

We can see patterns in physical things such as paving, tiling, linen, wood carvings and frames, and in diagrams. Mr Rasool made a patterned wooden sign to put over the door of his clothing shop.

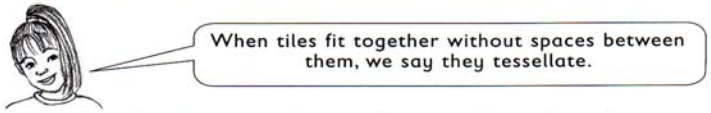
1 List at least five places where you can find patterns in your:
   a home
   b school
   c neighbourhood.

2 Some people have jobs that involve creating patterns. Can you think of a business where patterns are used?

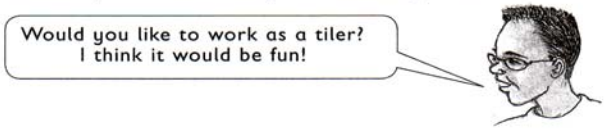


Esther Mahlangu is one of South Africa's most important Ndebele artists. She was born in Middelburg in 1935 and learned the skill of mural painting from her mother and grandmother. She has exhibited her work in various countries and was asked to create an African art car by painting a BMW with Ndebele-style patterns.

3 Draw ten squares, each 2 cm by 2 cm, and about ten rectangles, each 2 cm by 3 cm, and then cut them out.
   a Arrange the squares and rectangles to form a pattern that could be used to tile a floor. Remember, there must not be spaces between the "tiles".



   b Colour the squares one colour, and the rectangles another colour.
   c Glue them into your book to form your tessellated pattern.



18

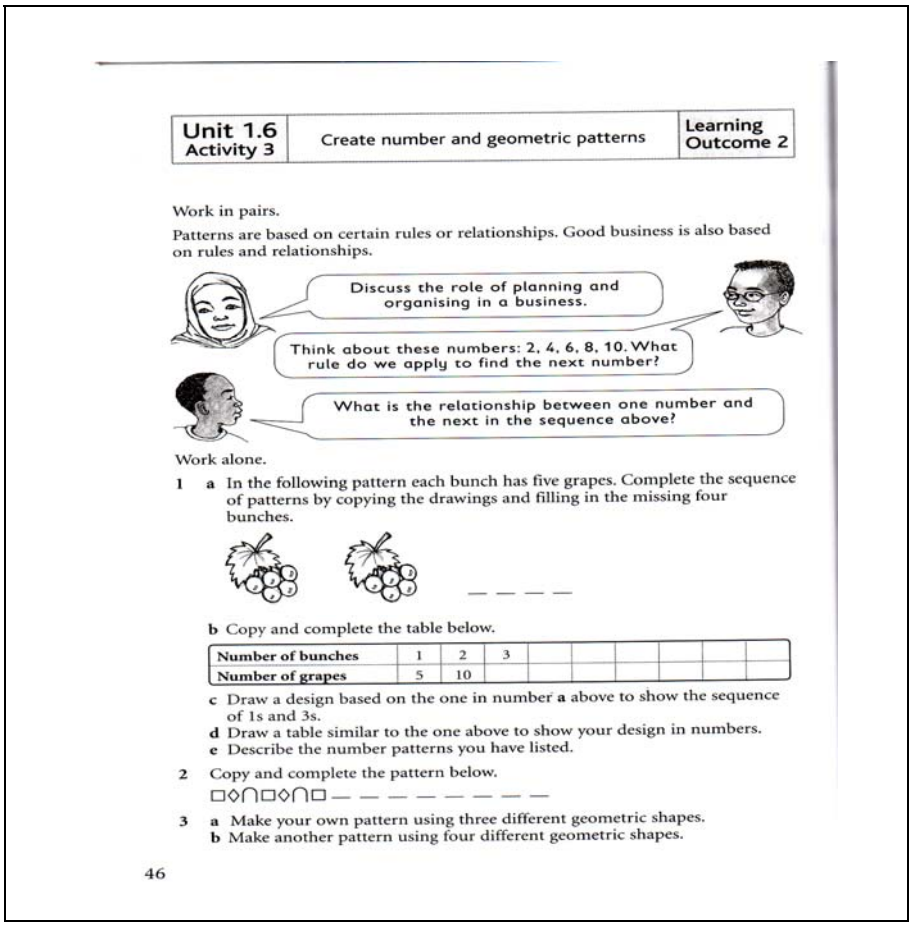
Figure 4.1: *A topic in the teacher's LSM* (Source: Yule et al., 2005: 18)

Drawing very heavily on Skemp's notion of concept formation I investigated to what extent the materials selected and used by the teacher promoted the understanding of the concept of variable. Some of the tools that I employed included identifying the possible primary concepts, past experiences, common features as well as contrasts and non-examples that were used or could be used in the materials. Although access to the material that was or could be used by the teacher to promote the understanding of the

concept of variable was sought, she provided the researcher with the assessment activities that she had used to assess the learners with regard to the concept of variable.

4.2.1 Presentation of the concept of variable in the materials availed by the teacher

The learning support materials that the teacher availed to the researcher present the concept of variable in a variety of manners where, for instance, number patterns, tables, the flow charts, placeholders are used as precursors and eventually a definition of the concept is presented. The use of number patterns as it is evident in the activities where learners are asked to describe relationships and predicting or finding numbers in a given sequence can be seen as a precursor to the introduction of formulae in which variables will be used to present their general form. This is shown in unit called '*create number and geometric patterns*' in which a table is also used to capture the numbers and this is where the idea of dependent and independent variables may be brewed.



Unit 1.6 Activity 3 | Create number and geometric patterns | **Learning Outcome 2**

Work in pairs.

Patterns are based on certain rules or relationships. Good business is also based on rules and relationships.

Discuss the role of planning and organising in a business.

Think about these numbers: 2, 4, 6, 8, 10. What rule do we apply to find the next number?

What is the relationship between one number and the next in the sequence above?

Work alone.

1 **a** In the following pattern each bunch has five grapes. Complete the sequence of patterns by copying the drawings and filling in the missing four bunches.

— — — —

b Copy and complete the table below.

Number of bunches	1	2	3					
Number of grapes	5	10						

c Draw a design based on the one in number **a** above to show the sequence of 1s and 3s.
d Draw a table similar to the one above to show your design in numbers.
e Describe the number patterns you have listed.

2 Copy and complete the pattern below.

□◇∩□◇∩□ — — — — — — — —

3 **a** Make your own pattern using three different geometric shapes.
b Make another pattern using four different geometric shapes.

46

Figure 4.2: *Use of number patterns* (Source: Yule et al., 2005: 46)

The idea of input, rule and output is used in the flow charts as shown on page 110 of the textbook (figure 4.3). The spaces in the output column that are indicated by dashes for the numbers that have to be filled in is reflective of the placeholders that are referred later in the materials as being represented by letters that will eventually be defined as variables.

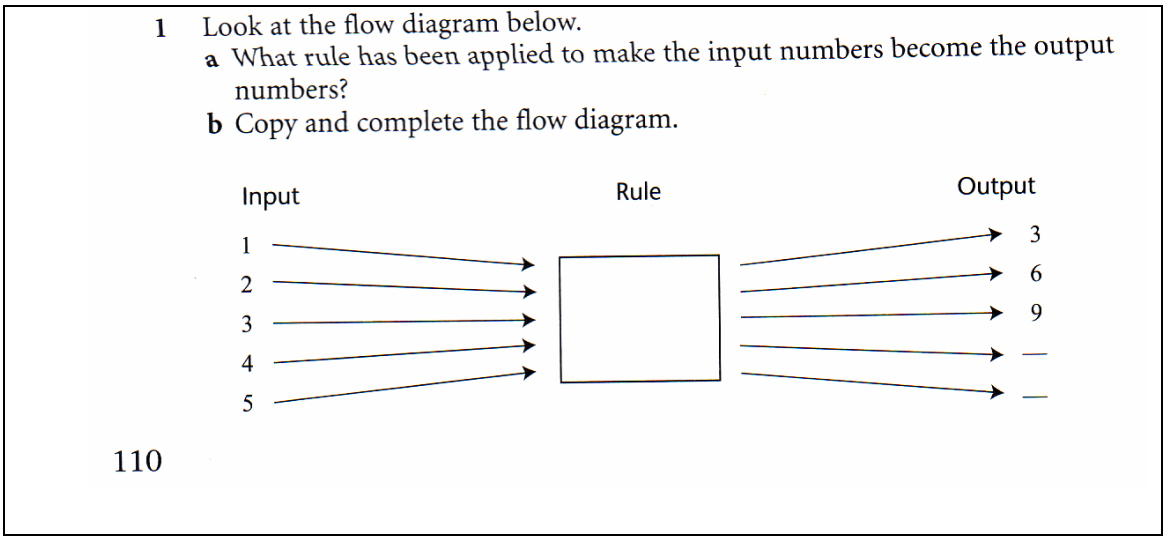


Figure 4.3: *Use of flow charts* (Source: Yule et al., 2005: 110)

In the subsequent units letters are used to represent the input and the outputs as evident in activity 2 of unit 2.6 on the page 112 in line with the view of presenting letters as standing in place of a variety of numbers. It warrants a mention however that even though at least one of the numbers viz. 32 is repeated as shown in parts 1(c) and 1(d) in the input column, none of the letters is repeated in any way in this activity.

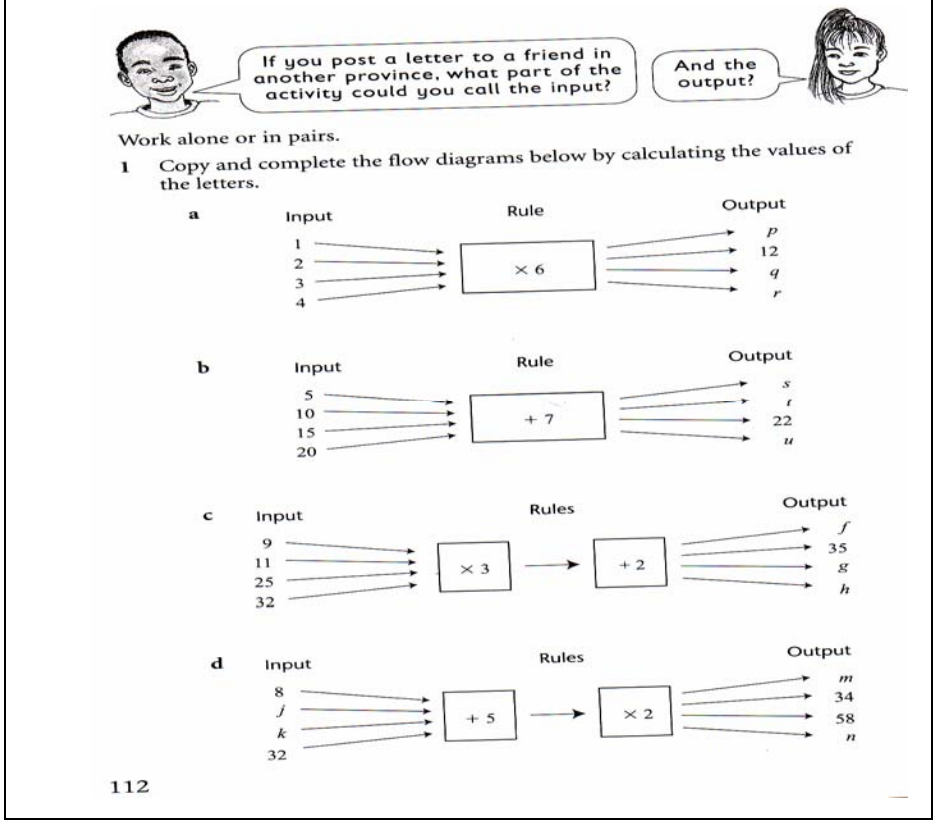
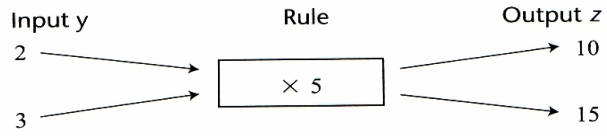


Figure 4.4: *Use of letters to represent input and output* (Source: Yule et al., 2005: 112)

In the preceding activity 1 of the very unit 2.6 the input is represented by a letter y and the output is represented by z while the flow chart is represented by a number sentence $y \times 5 = z$ as shown in figure 4.5. This activity may certainly be used as a precursor to the concept of function.

2 If the letter y represents the input, the letter z represents the output, and the rule is $\times 5$, then the number sentence for the diagram will be $y \times 5 = z$. Look at the flow diagram below and then answer the questions.



a If $y = 2$, what does z equal?
b If $y = 3$, what does z equal?
c What are the input numbers in the flow diagram?
d What are the output numbers?
e What is the rule?

Figure 4.5: *Use of letters to represent input and output* (Source: Yule et al., 2005: 111)

It is significant to note the difference in the use of letters in the two activities of unit 2.6. In activity 1 the letters are used to represent a variety of numbers, be they input or output, whereas in activity 2 the letters that are used represent only one specific number. It is important to highlight this important advantage of the use of letters in mathematics as this would not be possible with the exclusive use non-variable numbers.

The use of placeholders as a precursor to the introduction of variables as exemplified in the RNCS is also prevalent in the materials as shown in figure 4.5, where they used to introduce the letters that can stand in their place as shown on page180. The placeholder and the letter are eventually used in the definition of a variable.

Work in pairs.

1 Look at the following: $3 + \square = 8$.
a What is the value of $\square$?
b What is the value of p in $3 + p = 8$?

Figure 4.6: *Using placeholder to introduce the letters* (Source: Yule et al., 2005: 180)

The definition of variable is presented in the textbook in the form: 'In Grade one we learnt that placeholders, such as shapes, can be used to mark the place of a number. For example $\square + 4 = 5$. This year we learnt that we can use lower case letters of the alphabets as placeholders for numbers. For example, $b + 4 = 5$. We call the placeholder letter or

unknown, a variable' (Yule et al., 2005: 178). It is, however, significant to point out the absence of an indication of the use of the same letter to represent a variety of numbers in the definition.

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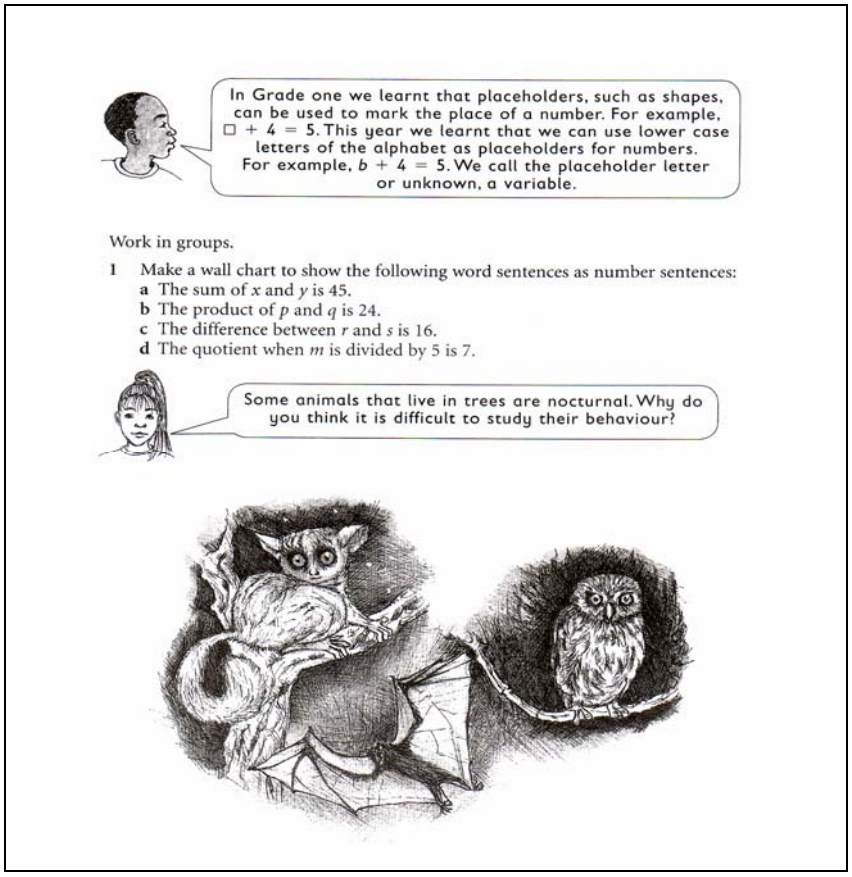


Figure 4.7: *Definition of variable in the LSM* (Source: Yule et al., 2005: 178)

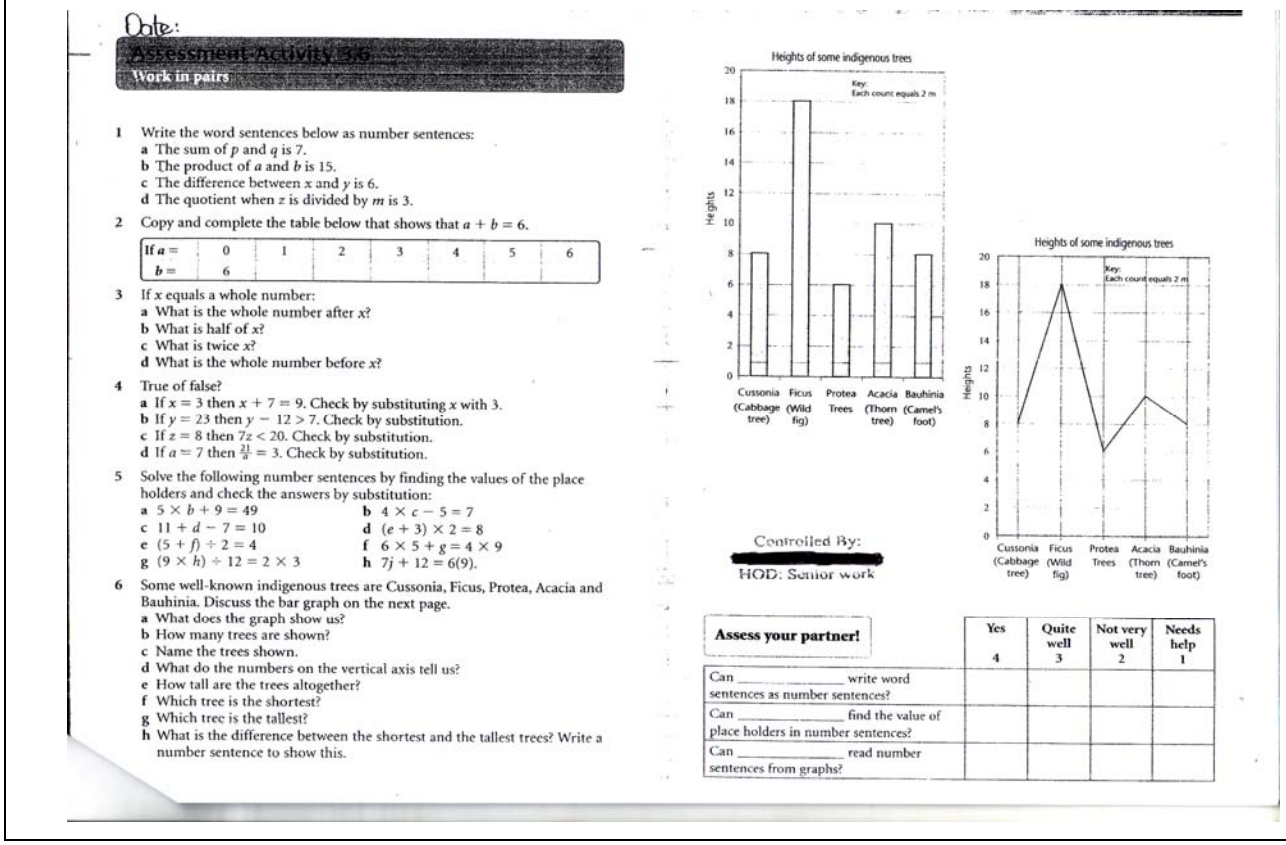
The apparent promotion of the understanding of the concept of variable in the materials availed by the teacher is that of working towards the development of a definition of variable in which the replacement of the *placeholder* by a *letter*, which is also called *unknown*, is pursued. It is interesting to note the sketches of the nocturnal animals that live in trees on this page where an indication of the difficulty of studying their behaviour is expresses, probably in reference to the apparent 'unknown' behaviour of these animals.

4.2.2 Analysis of the materials used by the teacher in the presentation of the concept of variable

The analyses that follow are those of the materials that the teacher indicated she had used in teaching the concept of variable. The teacher provided five assessment activities viz. 3.6, 3.7, 4.1, 4.2 and 4.3 and these were all apparently controlled by the school's head of department of the senior work (name obscured for ethical reasons). Although it appeared in the interview that the teacher's pedagogical content knowledge with regard to the concept of variable was inadequate, it was unexpected to note the adequacy of the materials that the teacher availed and had actually used in the teaching and learning of the concept. This finding supports the conjecture in Collopy's study that curriculum materials may facilitate teacher learning. It can be inferred that selection of the assessment activities had to do with the learning support materials themselves. Another possibility is that of interpreting the teacher's actions in terms of Remillard's (2005) conception of curriculum use, viz. following the text.

4.2.2.1 Assessment activity 3.6

In this assessment activity letters that are to be replaced by numbers are used and this is significantly in the majority of the parts of this activity, viz. 1, 2, 4 and 5. It is recommended in the activity that learners work in pairs and a table was to be utilised to show the variability of a and b in the number sentence $a + b = 6$. The heights of indigenous trees were used to generate the two graphs.



Date:

Assessment Activity 3.6

Work in pairs

1 Write the word sentences below as number sentences:
- **a** The sum of p and q is 7.
- **b** The product of a and b is 15.
- **c** The difference between x and y is 6.
- **d** The quotient when z is divided by m is 3.

2 Copy and complete the table below that shows that $a + b = 6$.

If a =	0	1	2	3	4	5	6
b =	6						

3 If x equals a whole number:
- **a** What is the whole number after x?
- **b** What is half of x?
- **c** What is twice x?
- **d** What is the whole number before x?

4 True of false?
- **a** If $x = 3$ then $x + 7 = 9$. Check by substituting x with 3.
- **b** If $y = 23$ then $y - 12 > 7$. Check by substitution.
- **c** If $z = 8$ then $7z < 20$. Check by substitution.
- **d** If $a = 7$ then $\frac{2a}{a} = 3$. Check by substitution.

5 Solve the following number sentences by finding the values of the place holders and check the answers by substitution:
- **a** $5 \times b + 9 = 49$
- **b** $4 \times c - 5 = 7$
- **c** $11 + d - 7 = 10$
- **d** $(e + 3) \times 2 = 8$
- **e** $(5 + f) \div 2 = 4$
- **f** $6 \times 5 + g = 4 \times 9$
- **g** $(9 \times h) \div 12 = 2 \times 3$
- **h** $7j + 12 = 6(9)$.

6 Some well-known indigenous trees are Cussonia, Ficus, Protea, Acacia and Bauhinia. Discuss the bar graph on the next page.
- **a** What does the graph show us?
- **b** How many trees are shown?
- **c** Name the trees shown.
- **d** What do the numbers on the vertical axis tell us?
- **e** How tall are the trees altogether?
- **f** Which tree is the shortest?
- **g** Which tree is the tallest?
- **h** What is the difference between the shortest and the tallest trees? Write a number sentence to show this.

Heights of some indigenous trees
Key: Each count equals 2 m
Heights
Cussonia (Cabbage tree)
Ficus (Wild fig)
Protea Trees
Acacia (Thorn tree)
Bauhinia (Camel's foot)

Controlled By:
[redacted]
HOD: Senior work

Assess your partner!	Yes 4	Quite well 3	Not very well 2	Needs help 1
Can _____ write word sentences as number sentences?				
Can _____ find the value of place holders in number sentences?				
Can _____ read number sentences from graphs?				

Figure 4.8: *Assessment activity 3.6* (Source: Yule et al., 2005: 178)

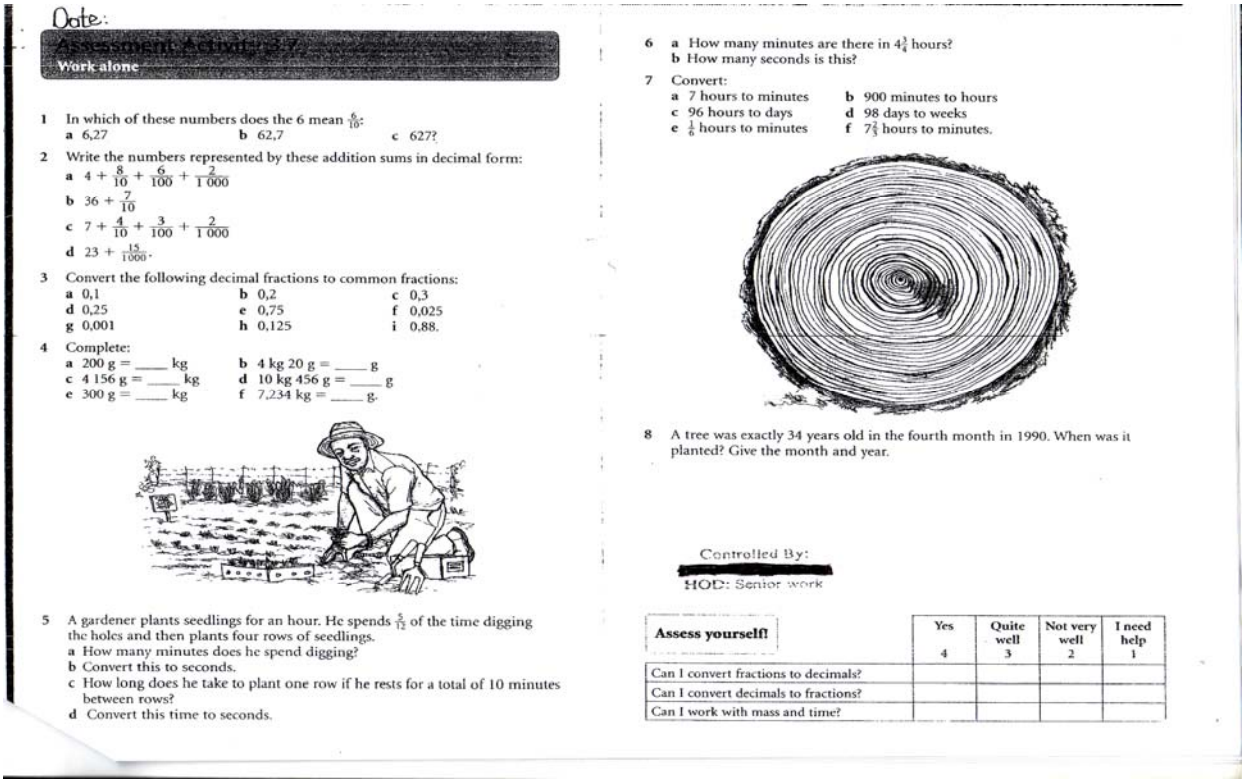
In the assessment activity 3.6, the past experiences that could possibly be used in the material were learners' experiences in arithmetic such that in activities parts 1 through to 5 of the activity, the learners' knowledge of addition of numbers, subtraction of numbers, multiplication of numbers and division of numbers was required. In all the instances the variability of the numbers that are to be substituted in the closed sentences is apparent, as letters in the place of a variety of numbers. With the definition such as 'variables are letters used in the place of number', where the notion of place holder is also apparent, the concept of variable is captured in terms of the substitutive function of the numbers to be used in the place of the letters. In the parts 1 and 2 the variability of the variables is captured by the apparent infinite number of solutions for the closed sentences. The use of contrast and non-examples is not apparent in parts 1 to 5. In part 6, the past experiences assumed to be there for learners is also in the form of arithmetic as well as the use of trees, a contextual object, and the determination of varying heights, a measurement that is

part of everyday activity. By the process of mathematisation which is defined in Van Etten & Smit (2005) as the translation of contexts into mathematics, the variable differences identifiable in the kinds of trees mentioned in the activity are ignored in answering the question 6b "How many trees are shown?" The objectification of trees as equal to one another needs to be employed in order to generate the answer. It is critical to point out that in the activity, the use of non-examples such as *fruits* will not be counted in generating the answer to activity 6b just in the same way that *x*'s will not be counted with the *y*'s. The determination of the difference between the shortest and the longest trees is also possible through the process of mathematisation of the heights of the trees, where despite the inherent inaccuracy associated with measurement, an everyday contextual activity, a calculation, albeit inherently impossible, can be done. The miniscule differences in the measuring will be disregarded through mathematisation and hence approximate consensus-driven equalisation of variable measurements is possible.

In terms of part 3 of the activity, the concept of whole number would render the formation of the concept of variable possible by using the former as a higher level formation where the understanding of what is meant by whole number would first of all be necessary. Secondly the sequencing of whole numbers will be pre-requisite and thirdly the association between adjacent successive terms of whole numbers would also be required to be known. The use of variables as representative of whole numbers also gives credence to the notion of viewing algebra as generalised arithmetic since the understanding of whole numbers together with the order of their sequencing has the potential of illuminating the general form of the representation of whole numbers. The common features in terms of concept of variable in as far as the examples that were used are concerned in the assessment activity 3.6 were the use of letters in parts 1 to 5. The use of the attribute of height in activity 6 highlights the importance of the mathematisation of a common attribute where despite the inaccuracies associated with everyday activities or occurrences, mathematical calculations are still possible. The graphing of the relationship between the trees and their respective heights serve as precursors for dependent and independent variables which are associated with the concept of function.

4.2.2.2 Assessment activity 3.7

Learners were expected to work alone in this activity and working with fractions was its main thrust. It contained a sketch of a gardener planting seedlings where learners were asked to calculate the time he spends on his work. Another sketch was that of a cross-section of a bark of a tree with learners asked to determine when the tree was planted. The word 'exact' is used in the activity even though in terms of real life context that is undeterminable. Part 4 of the activity shows the use of place-holders where learners are to convert grams to kilograms and vice-versa.



Date:

Assessment Activity 3.7

Work alone

1 In which of these numbers does the 6 mean $\frac{6}{10}$:
a 6,27 b 62,7 c 627?

2 Write the numbers represented by these addition sums in decimal form:
a $4 + \frac{8}{10} + \frac{6}{100} + \frac{2}{1\,000}$
b $36 + \frac{7}{10}$
c $7 + \frac{4}{10} + \frac{3}{100} + \frac{2}{1\,000}$
d $23 + \frac{15}{1000}$.

3 Convert the following decimal fractions to common fractions:
a 0,1 b 0,2 c 0,3
d 0,25 e 0,75 f 0,025
g 0,001 h 0,125 i 0,88.

4 Complete:
a 200 g = ____ kg b 4 kg 20 g = ____ g
c 4 156 g = ____ kg d 10 kg 456 g = ____ g
e 300 g = ____ kg f 7,234 kg = ____ g.

5 A gardener plants seedlings for an hour. He spends $\frac{5}{12}$ of the time digging the holes and then plants four rows of seedlings.
a How many minutes does he spend digging?
b Convert this to seconds.
c How long does he take to plant one row if he rests for a total of 10 minutes between rows?
d Convert this time to seconds.

6 a How many minutes are there in $4\frac{3}{4}$ hours?
b How many seconds is this?

7 Convert:
a 7 hours to minutes b 900 minutes to hours
c 96 hours to days d 98 days to weeks
e $\frac{1}{6}$ hours to minutes f $7\frac{2}{5}$ hours to minutes.

8 A tree was exactly 34 years old in the fourth month in 1990. When was it planted? Give the month and year.

Controlled By:
HOD: Senior work

Assess yourself!	Yes 4	Quite well 3	Not very well 2	I need help 1
Can I convert fractions to decimals?				
Can I convert decimals to fractions?				
Can I work with mass and time?				

Figure 4.9: *Assessment activity 3.7* (Source: Yule et al., 2005: 178)

The use of past experiences in this assessment activity is in terms of mass or weight, arithmetic, conversions and substitution as well as decimals. In activity 4, the issue of conversions and substitution comes to the fore and the mathematisation of the mass or weight is expedited, for example, if $m = 2n$ then $m + 2n = 2n + 2n = 4n$ or

$= m + m = 2m$

The activity that is given to the learners can therefore be dealt in a similar manner, since if $1000g = 1kg$ then $200g + 1kg = 0{,}2kg + 1kg = 1{,}2kg$ or

$= 200g + 1000g = 1200g$

It is apparent in the example above that variable measurements such as that of weights may be converted and/or substituted with a variety of different units of weight thus emphasising the necessity of the sub-conception of variability.

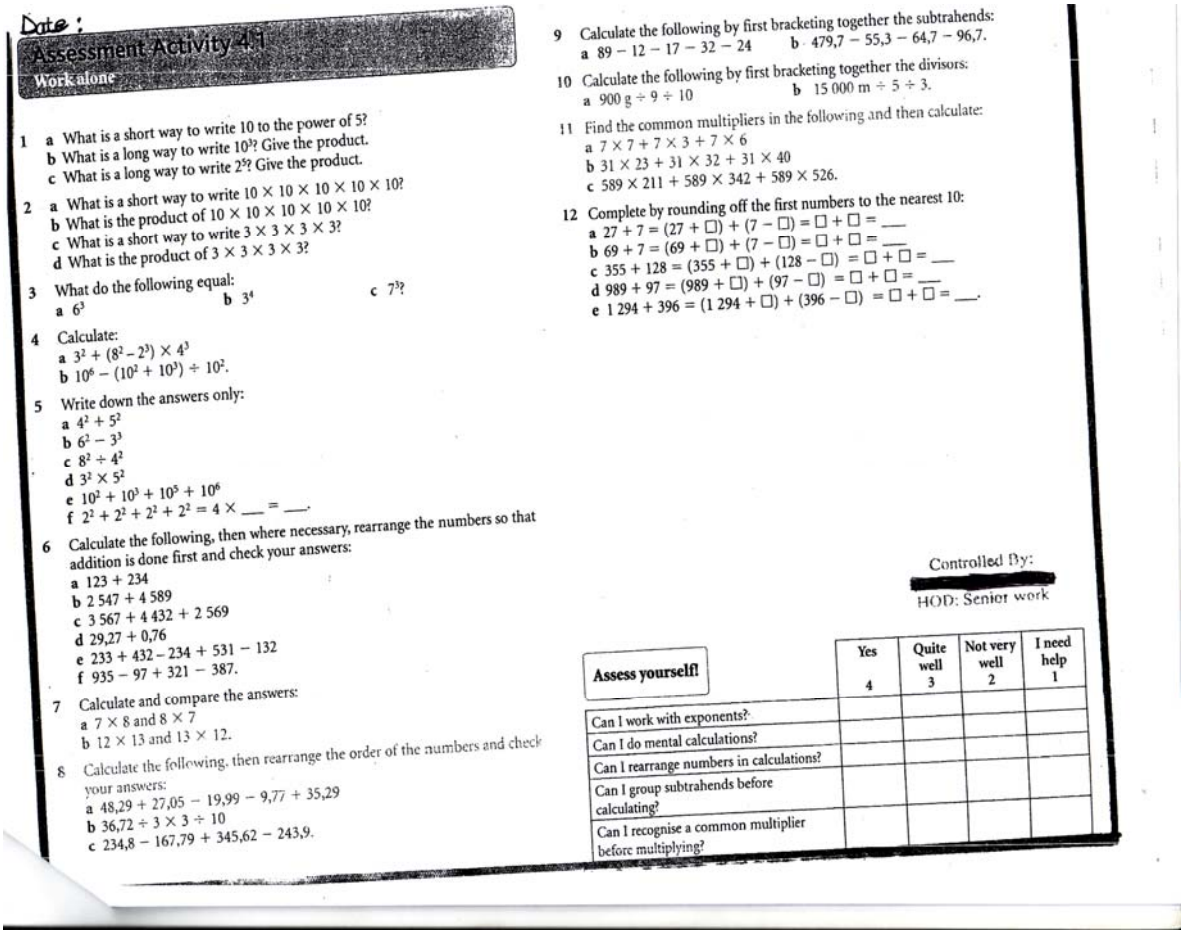
In parts 5 to 8 of the activity the past experiences utilised are once more conversion and substitution together with the quantity of time in which the units such as seconds, minutes, hours, days, weeks, months and years are utilised. It is apparent that the units that are used for time are themselves not necessarily the same in quantity and the examples that spring to mind instantly are that of months and years, which respectively have 28, 29, 30 or 31 and 365 or 366 days and are therefore variable. The mathematisation of time in terms of its measurement can never be exact and this is where the concept of variable in the form of identified units fits in when it comes to the operation on common objects, quantity, quality or character - created by the inequality of everyday experiences - that is requisite in mathematics when the quantifying of these is done. The common feature identifiable in these activities is the mathematisation of the everyday experience, time.

The numbers that are depicted in parts 1 through to 3 of this assessment activity are generated by the base ten (b-10) system. If the activity 2a is used as an example, then $4 + {}^{8}/_{10} + {}^{6}/_{100} + {}^{2}/_{1000}$ (Yule et al., 2005: 208) is actually 4 ones + 8 tenths + 6 hundredths + 2 thousandths, which the system makes it possible for us to write without indicating the units involved such that the sum can be represented as 4,862. In recognising that fractions are representative of parts of a whole and it is practically impossible to be able to accurately divide any real life object into exactly the same equal parts, it becomes apparent that mathematisation is necessary. Therefore the closest we can manage to get 2 hundredths in real life situations from 2 same numbers would be by having added exactly the same 1 hundredths, an impossibility, and hence the importance

of the mathematisation of the variable everyday experiences which the b-10 system is certainly a part of.

4.2.2.3 Assessment activity 4.1

The activity contained a variety of mathematical operations such that decimal fractions and powers were covered. Although no letters are depicted in this activity the placeholders are used in parts 5(f) and 12(a) to 12(e).



Date :

Assessment Activity 4.1

Work alone

1 a What is a short way to write 10 to the power of 5?
b What is a long way to write 10^5? Give the product.
c What is a long way to write 2^5? Give the product.

2 a What is a short way to write $10 \times 10 \times 10 \times 10 \times 10$?
b What is the product of $10 \times 10 \times 10 \times 10 \times 10$?
c What is a short way to write $3 \times 3 \times 3 \times 3$?
d What is the product of $3 \times 3 \times 3 \times 3$?

3 What do the following equal:
a 6^3 b 3^4 c 7^3?

4 Calculate:
a $3^2 + (8^2 - 2^3) \times 4^3$
b $10^6 - (10^2 + 10^3) \div 10^2$.

5 Write down the answers only:
a $4^2 + 5^2$
b $6^2 - 3^3$
c $8^2 \div 4^2$
d $3^2 \times 5^2$
e $10^2 + 10^3 + 10^5 + 10^6$
f $2^2 + 2^2 + 2^2 + 2^2 = 4 \times __ = __$.

6 Calculate the following, then where necessary, rearrange the numbers so that addition is done first and check your answers:
a 123 + 234
b 2 547 + 4 589
c 3 567 + 4 432 + 2 569
d 29,27 + 0,76
e 233 + 432 − 234 + 531 − 132
f 935 − 97 + 321 − 387.

7 Calculate and compare the answers:
a 7×8 and 8×7
b 12×13 and 13×12.

8 Calculate the following, then rearrange the order of the numbers and check your answers:
a 48,29 + 27,05 − 19,99 − 9,77 + 35,29
b $36{,}72 \div 3 \times 3 \div 10$
c 234,8 − 167,79 + 345,62 − 243,9.

9 Calculate the following by first bracketing together the subtrahends:
a 89 − 12 − 17 − 32 − 24 b 479,7 − 55,3 − 64,7 − 96,7.

10 Calculate the following by first bracketing together the divisors:
a 900 g ÷ 9 ÷ 10 b 15 000 m ÷ 5 ÷ 3.

11 Find the common multipliers in the following and then calculate:
a $7 \times 7 + 7 \times 3 + 7 \times 6$
b $31 \times 23 + 31 \times 32 + 31 \times 40$
c $589 \times 211 + 589 \times 342 + 589 \times 526$.

12 Complete by rounding off the first numbers to the nearest 10:
a $27 + 7 = (27 + \square) + (7 - \square) = \square + \square = __$
b $69 + 7 = (69 + \square) + (7 - \square) = \square + \square = __$
c $355 + 128 = (355 + \square) + (128 - \square) = \square + \square = __$
d $989 + 97 = (989 + \square) + (97 - \square) = \square + \square = __$
e $1\,294 + 396 = (1\,294 + \square) + (396 - \square) = \square + \square = __$.

Controlled By:
[redacted]
HOD: Senior work

Assess yourself!	Yes 4	Quite well 3	Not very well 2	I need help 1
Can I work with exponents?				
Can I do mental calculations?				
Can I rearrange numbers in calculations?				
Can I group subtrahends before calculating?				
Can I recognise a common multiplier before multiplying?				

Figure 4.10: *Assessment activity 4.1* (Source: Yule et al., 2005: 178)

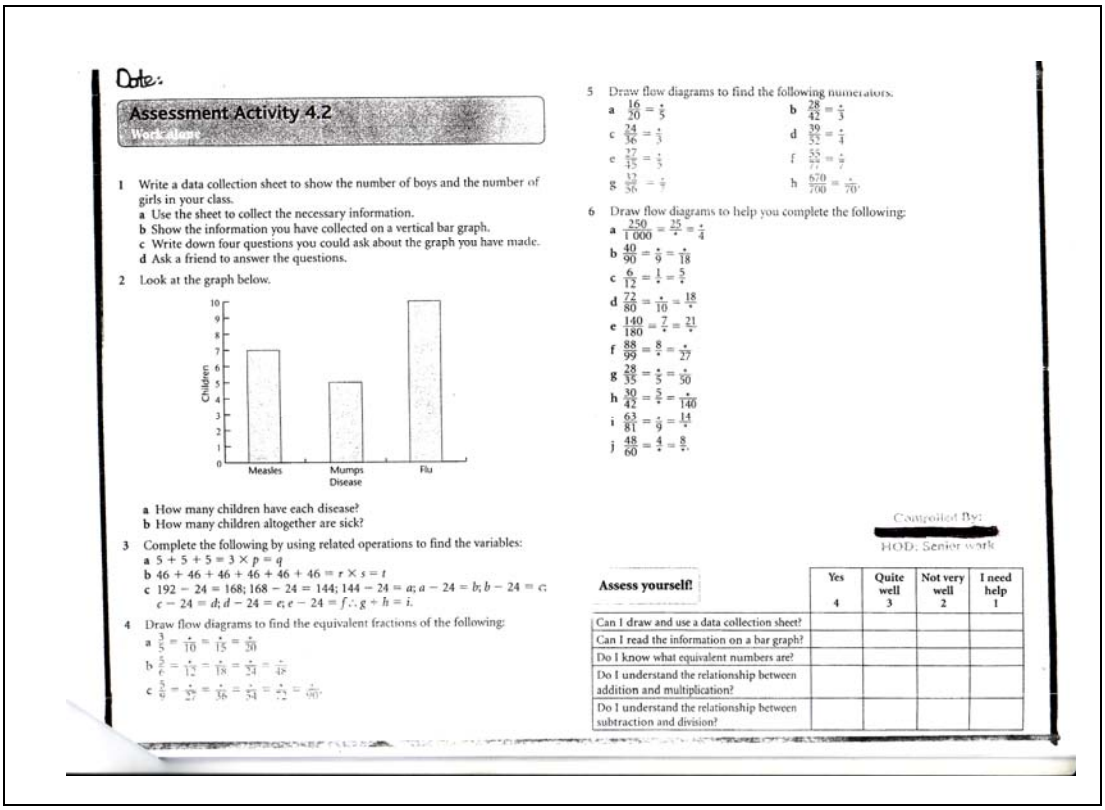
In the assessment activity 4.1 only the concept of power as a primary concept in the formation of the concept of variable was selected for analysis together with the use of place-holders as past experiences that the texts are using for the development of the concept that is the focus of this study. The parts 6 to 10 of the activity have already been

addressed in the preceding analyses. The concept of power is considered as primary due to the fact that the understanding of bases and exponents is necessary. Without actually stating the obvious, there can be no denying the high level status of the concept of the power in mathematics where the usage of the concept of variable in the development of generalised rules in the multiplication or division of same based powers is essential as captured by the respective addition or subtraction of their exponents in the examples that follow: $x^a \times x^b = x^{a+b}$ or $y^m \div y^n = y^{m-n}$.

In activity 12 the place holders conventionally regarded as the items that are replaced by letters that are called variables in the learners' development of the concept are used. This is consistent with what is captured very clearly in the Grade 7 assessment standards of the RNCS which state that 'We know this when the learner solves or completes number sentences by inspection or by trial-and- improvement, checking the solution by substitution (e.g. $2\times\square - 8 = 4$)' (DoE, 2002, p.74).

4.2.2.4 Assessment activity 4.2

Graphs are once more utilised in this activity as well as letters and place-holders that are to be replaced by numbers. Learners are expected to utilise flow diagrams in the determination of equivalent fractions.



Date:

Assessment Activity 4.2

Work sheet

1 Write a data collection sheet to show the number of boys and the number of girls in your class.
a Use the sheet to collect the necessary information.
b Show the information you have collected on a vertical bar graph.
c Write down four questions you could ask about the graph you have made.
d Ask a friend to answer the questions.

2 Look at the graph below.

a How many children have each disease?
b How many children altogether are sick?

3 Complete the following by using related operations to find the variables:
a $5 + 5 + 5 = 3 \times p = q$
b $46 + 46 + 46 + 46 + 46 + 46 = r \times s = t$
c $192 - 24 = 168; 168 - 24 = 144; 144 - 24 = a; a - 24 = b; b - 24 = c; c - 24 = d; d - 24 = e; e - 24 = f; f - 24 = g + h = i.$

4 Draw flow diagrams to find the equivalent fractions of the following:
a $\frac{3}{5} = \frac{\bullet}{10} = \frac{\bullet}{15} = \frac{\bullet}{20}$
b $\frac{5}{6} = \frac{\bullet}{12} = \frac{\bullet}{18} = \frac{\bullet}{24} = \frac{\bullet}{48}$
c $\frac{5}{9} = \frac{\bullet}{27} = \frac{\bullet}{36} = \frac{\bullet}{54} = \frac{\bullet}{72} = \frac{\bullet}{90}$

5 Draw flow diagrams to find the following numerators.
a $\frac{16}{20} = \frac{\bullet}{5}$
b $\frac{28}{42} = \frac{\bullet}{3}$
c $\frac{24}{36} = \frac{\bullet}{3}$
d $\frac{39}{52} = \frac{\bullet}{4}$
e $\frac{77}{35} = \frac{\bullet}{5}$
f $\frac{55}{77} = \frac{\bullet}{7}$
g $\frac{57}{56} = \frac{\bullet}{8}$
h $\frac{670}{700} = \frac{\bullet}{70}$

6 Draw flow diagrams to help you complete the following:
a $\frac{250}{1\,000} = \frac{25}{\bullet} = \frac{\bullet}{4}$
b $\frac{40}{90} = \frac{\bullet}{9} = \frac{\bullet}{18}$
c $\frac{6}{12} = \frac{1}{\bullet} = \frac{5}{\bullet}$
d $\frac{72}{80} = \frac{\bullet}{10} = \frac{18}{\bullet}$
e $\frac{140}{180} = \frac{7}{\bullet} = \frac{21}{\bullet}$
f $\frac{88}{99} = \frac{8}{\bullet} = \frac{\bullet}{27}$
g $\frac{28}{35} = \frac{\bullet}{5} = \frac{\bullet}{50}$
h $\frac{30}{42} = \frac{5}{\bullet} = \frac{\bullet}{140}$
i $\frac{63}{81} = \frac{\bullet}{9} = \frac{14}{\bullet}$
j $\frac{48}{60} = \frac{4}{\bullet} = \frac{8}{\bullet}$

Compiled by:
HOD: Senior work

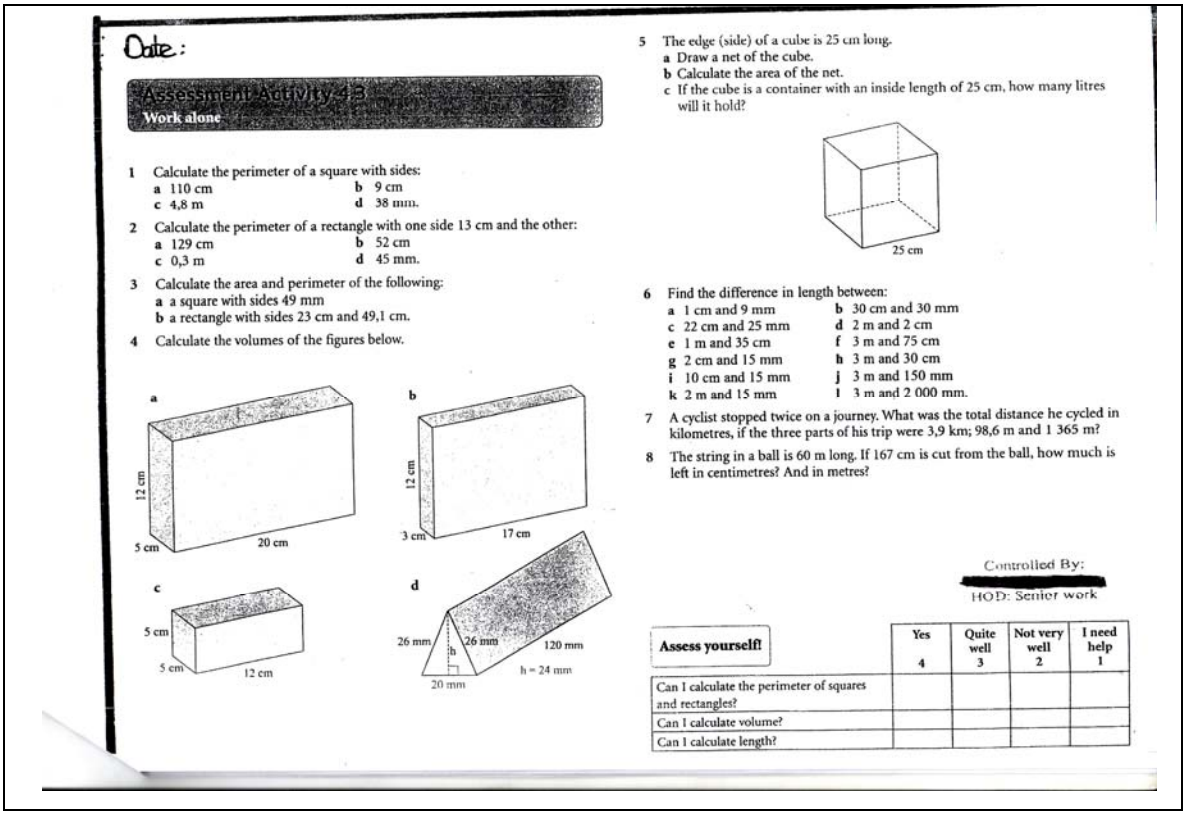
Assess yourself!	Yes 4	Quite well 3	Not very well 2	I need help 1
Can I draw and use a data collection sheet?				
Can I read the information on a bar graph?				
Do I know what equivalent numbers are?				
Do I understand the relationship between addition and multiplication?				
Do I understand the relationship between subtraction and division?				

Figure 4.11: *Assessment activity 4.2* (Source: Yule et al., 2005: 178)

The past experiences used in the assessment activity 4.2 parts 1 and 2 are: boys and girls, sicknesses and diseases where mathematisation, by disregarding the inherent differences of the contexts, will certainly have to be employed by learners. In activity 3, arithmetic forms part of the past experiences used in the form of addition, subtraction, multiplication and division of numbers to charter into the unfamiliar usage of letters in place of numbers. Of greater importance in this activity is that in terms of the materials selected by the teacher it is the only activity in which the term *variable* is visibly depicted in part 3 where learners are asked to: 'Complete the following by using related operations to find the variables:' (Yule et al., 2005: 206). In this very activity the perfect opportunity for contrasting is provided as evident in the example $5 + 5 + 5 = 3 \times p = q$. Although the answer q is depicted by a single letter, it is representative of a two digit number 15. In parts 4 to 6 of the activity, equivalent fractions are used. The variable forms of the representation of equivalent fractions enhance the concept of *variable*.

4.2.2.5 Assessment activity 4.3

The thrust of this activity is the determination of measurement by learners and this is signified by the indispensable letters of the units of measurement. Conversions of the units of measurement from one to another are once more prevalent in parts 6, 7 and 8.



Date:

Assessment Activity 4.3

Work alone

1 Calculate the perimeter of a square with sides:
a 110 cm b 9 cm
c 4,8 m d 38 mm.

2 Calculate the perimeter of a rectangle with one side 13 cm and the other:
a 129 cm b 52 cm
c 0,3 m d 45 mm.

3 Calculate the area and perimeter of the following:
a a square with sides 49 mm
b a rectangle with sides 23 cm and 49,1 cm.

4 Calculate the volumes of the figures below.

a

b

c

d

5 The edge (side) of a cube is 25 cm long.
a Draw a net of the cube.
b Calculate the area of the net.
c If the cube is a container with an inside length of 25 cm, how many litres will it hold?

6 Find the difference in length between:
a 1 cm and 9 mm b 30 cm and 30 mm
c 22 cm and 25 mm d 2 m and 2 cm
e 1 m and 35 cm f 3 m and 75 cm
g 2 cm and 15 mm h 3 m and 30 cm
i 10 cm and 15 mm j 3 m and 150 mm
k 2 m and 15 mm l 3 m and 2 000 mm.

7 A cyclist stopped twice on a journey. What was the total distance he cycled in kilometres, if the three parts of his trip were 3,9 km; 98,6 m and 1 365 m?

8 The string in a ball is 60 m long. If 167 cm is cut from the ball, how much is left in centimetres? And in metres?

Controlled By:
[redacted]
HOD: Senior work

Assess yourself!	Yes 4	Quite well 3	Not very well 2	I need help 1
Can I calculate the perimeter of squares and rectangles?				
Can I calculate volume?				
Can I calculate length?				

Figure 4.12: *Assessment activity 4.3* (Source: Yule et al., 2005: 178)

The assessment activity 4.3 utilises the primary concepts of perimeter, area, volume, rectangle and cube in which case the process of mathematisation is necessary in as far as the measurement of objects is concerned.

It is apparent following the analyses of the materials in possession and/or used by the teacher that it may not be unreasonable to come to the conclusion that contexts with which the concepts of variable could be promoted in an understandable manner amongst learners was possible. In terms of teacher's use of curriculum materials it appears that she took the positivist perspective of following and subverting the text. The perspectives of drawing on, interpreting and participating with the text was not apparent.

4.3 Analysis of the interview

The main interview of the teacher was conducted after the administration of a questionnaire, the preliminary interview, where the biographical details pertaining to the teacher were the main focus, as well as the collection of resource materials used by the teacher, in the form of the textbook that was provided by the teacher.

The initial responses by the teacher to the question: "What do you understand by the term variable?" had the potential to throw a study such as the one that I was pursuing into disarray. Her responses: "Honestly I don't understand that term. I don't understand it. What does it mean? What does it entail? But I heard it before but I don't understand it" and "…I don't have a clue as I said the other day: what is this guy talking about? I don't have a clue…", prompted several questions. By indicating that she had no idea of what is meant by the term variable Bongi was in a way reflecting on her pedagogical content knowledge (PCK) with regard to the concept of variable. The level of participation by the teacher with regard to the concept of variable was reflected in the analysis as limited to the replacement of numbers by letters that are called unknowns. The advantages of carrying out a semi-structured interview came to the rescue of having to overcome the hiccup experienced at the initial stages of the interview as the questions that had been prepared beforehand had to be revised, reordered and in some cases changed or abandoned in order to accommodate as well as to keep abreast with the teacher's responses.

The analysis of the interview was based on the *classroom participation model* adopted in this study's theoretical framework. Elements of this *classroom participation model* consist of the socio-cultural context, the teacher, the learner as well as the classroom participation. The teacher's apparent conception of the concept of variable and the teacher's views of the use of contexts were also explored. Drawing again on Skemp's notion of concept formation I investigated what informed the teacher's selections in her endeavour to promote the understanding of the concept of variable amongst her learners. Using the tools provided by Skemp of the primary concepts, past experiences used,

common features of experiences, contrasts and non-examples, I explored to what extent these were utilised by the teacher.

4.3.1 The Classroom Participation Model

In terms of the *classroom participation model* described in this report it is apparent that the teacher's role as old-timer was determining what she would select for participation with the learners. In spite of the fact that the materials that the teacher had selected had letters other than *x* as representing variables, the teacher opted to use only the *x* in her teaching and this is captured in the utterance:

> You know I have been working this year only with the *x*'s not so with the *y*. How to work with the *x*'s but I was telling my kids that next year they will learn more of the alphabetic words when they go to high school, more of the letters *a, b, c* and upwards. But this year I have been working on the value of *x*. How to "work out *x*". I have been working on that.

It is also apparent that even though the learners may have had some access to the same materials in the form of the mathematics prescribed textbook, for instance, it was the teacher who was determining the form and the level of 'participation' regarding the learner's 'apprenticeship' in the understanding of the concept of variable. The following figure captures the form of the 'participation' and inadvertently signifies the importance of the role that is played by the teacher in this process.

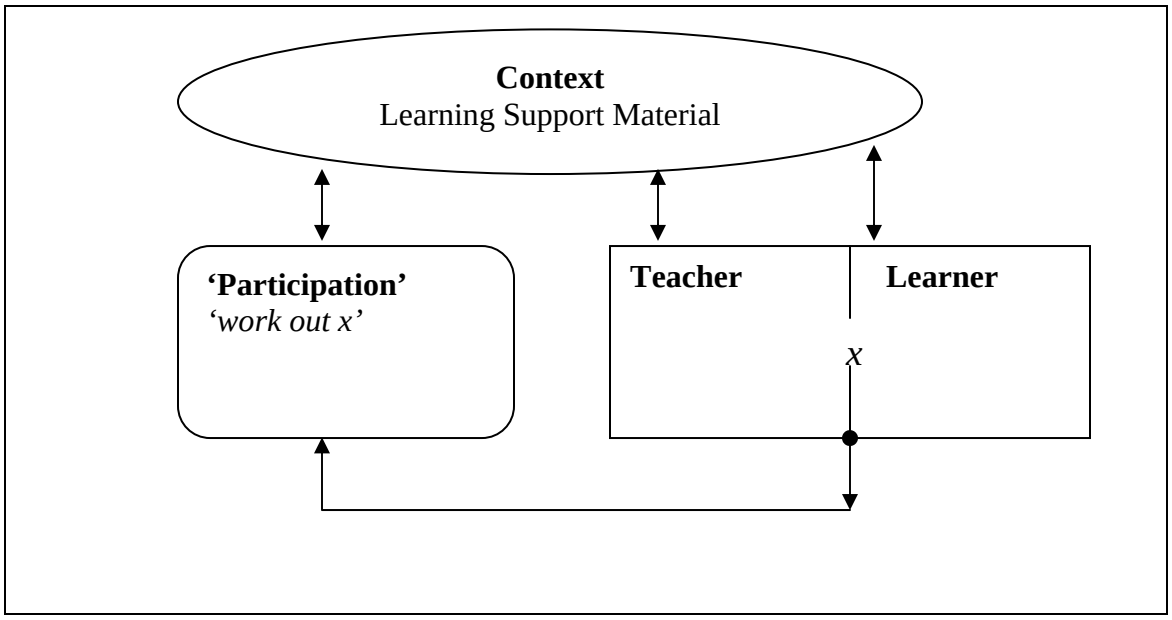


Figure 4.13: *'Participation' by teacher relating to the use of x*

Using this model the teacher selects only the *x* and communicates its exclusive usage to other letters by indicating to the learners that the other letters will be dealt with later in their schooling. As a result, even though the learner is exposed to other letters as evident in the assessment activity 3.6 (figure 4.7) – selected by the teacher to be done by the learners – the 'participation' in the class as far as the teacher was concerned regarding the concept of variable was apparently in terms of 'working out the *x*'.

The teacher's preference to participate with the learners with regard to the concept of variable only in terms the one letter *x* and not with the *y* or any other letter is reflective of the other factors inclusive of personal experience and the environment that were identified as having direct influence on teachers' actions (Pearce and Loyd, 1987; Garett, 1978 and Muskin, 1990). Apparently, the teacher took the view that the environment that the learners were at, namely primary level, was not appropriate for the introduction of more than one letter in terms of promoting the understanding of the concept of variable. Despite the absence of a statement in the curriculum advocating for the exclusive usage of *x* in the teaching and learning of the concept of variable to learners at Grade 7, the

teacher's actions can be attributed to her personal experience. The teacher had certainly not been exposed to the concept of variable at the same level at which it is exposed to her learners and she could therefore probably felt that a wide exposure may be detrimental to her learners. It is worth noting the influence that such factors have on teacher's actions as apparently the materials that the teacher had used, as reflected in figure 4.8, did not make the teacher abandon the course of how she envisaged her interaction with the learners regarding the exclusive use of the letter *x*. The other letters in the materials such as *a*, *b*, *p*, *q*, *y* and *z* in parts 1, 2, 4 and 5 of the activity could not have gone unnoticed by the teacher in her interaction with the learners and hence their exclusion in terms of classroom participation with the learners demonstrates the power that teacher hold in this process. It is worth noting that the teacher had already interacted with the learners with regard to the concept of variable in the second term of the year. The interview was conducted much later in the first week of the last quarter. It was therefore apparent that the learning support materials that contained letters other than *x* purported to be used by the teacher had little effect in the teacher's maintenance of the exclusive usage of *x* when participating with the learners in the classroom. Bernstein (1982) offers the construct of framing to explain this scenario. Framing refers to the degree of control that the teacher and learner possess over the selection, organisation, pacing and timing of the knowledge used in the pedagogical relationship. The stronger the frames the more reduced the power of learners is over what, when and how the knowledge is used and this leads to a concomitant increase in power of the teacher in the pedagogical relationship. The power that the teacher held with regard to the participation is evident in the statement:

> … I was telling my kids that next year they will learn more of the alphabetic words when they go to high school, more of the letters *a, b, c* and upwards. But this year I have been working on the value of *x.*

It can be inferred that learners in the classroom participation with the teacher were involved at reduced levels of the promotion of understanding of the concept of variable as the exclusion of other letters implied reduced scope of participation. Were activities that included more than one letter, for instance, ignored in the classroom participation? This finding concurs with that of Collopy (2003) that curriculum materials do not always

support teacher learning and it can also be interpreted in terms of Remillard's (2005) conception of curriculum use which is that of subverting the text.

4.3.2 Teacher's apparent conception of the concept of variable

Having initially indicated that she did not understand the term 'variable' it became apparent later in the interview that some form of understanding of the concept was prevalent in the teacher. There is also evidence that the teacher had probably seen the term *variable* before this study as captured in the assessment activity 4.2 part 3, where learners are expected to: '… to find the variables:'. The apparent kind of understanding that the teacher had of the concept was firstly, abstract. There appeared to be no connection between the concept of variable that the teacher conveyed in the study with any sensory or motor level experiences as requisite in concept formation. Secondly in terms of the levels of concept formation it appeared to be somewhere between the primary and the secondary level in the conceptual hierarchy and to be specific at the sub-concept of unknown or a letter that replaces a number. This is in consideration of the utterance by the teacher that she "had worked with the *x*'s" before the interview and to be particular, in the second term of the year of this study. It is also apparent that she had no higher level formation of the concept in relation to conceptual hierarchy in consideration that viewing the concept of variable in terms of variability or any other form, for instance, was conspicuously absent in all the interactions with the teacher during this study. While it was apparent that she was familiar with the *x*'s and viewing them in terms of the 'unknown', she was unable to trace these back to the sensory and motor level of experiences. At one stage of the interview she said: "I don't know how to say *x*". The accompanying figure 4.13 captures the possible conception of the concept of variable and it is reasonable to infer that absence of the other links that position the concept at the level with which the adjacent experiences and/or sub-concept are identifiable may lead to an impoverished conception of the concept.

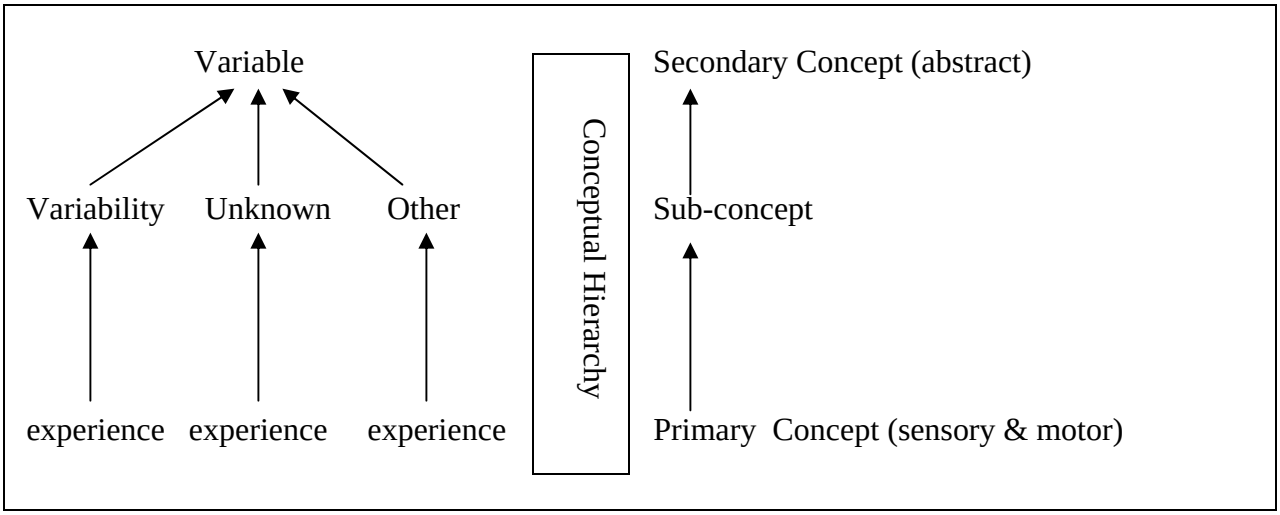


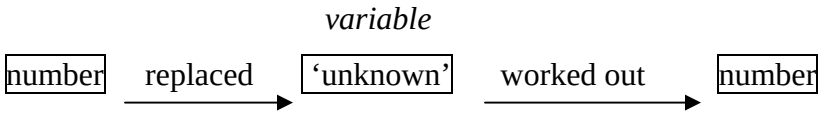
Figure 4.14: *Conceptual hierarchy of the variable*

The teacher's apparent conception of the concept of variable appeared not to have any hierarchical linkages in terms of the formation of a concept and seemed to be isolated as a sub-concept of 'an unknown number that is replaced by a letter' with neither the lower primary conception level nor the upper secondary level of the concept in existence. It has to be taken into consideration that other sub-concepts are required for the formation of a secondary concept. It is apparent that the concept of variable becomes more functional at the sub-concept level. Using variability as means of identifying a variable, for instance, is different than viewing the variable as an indication of a number that is not known. This functionality is also captured in the other descriptions of a variable such as a 'a letter that is used in formulas and mathematical expressions' (Abdelnoor, 1979), 'where letters appear in a number sentence (equation) assuming different values which make the number sentence true' (Dekker and Visser, 1984), 'a letter or other symbol that is used to represent any number in a specified set' (Cobran, 1982) and 'a letter that represents more than one solution set' (Dlamini, 2004). As the invariant properties related to each sub-concept tend to functionality, the concomitant lessening of the perceptual properties are also illuminated. For example, variability, unknown and letter are themselves perceptually more variant.

With sensory and motor experiences followed by abstraction it is apparent that the sub-concept of 'unknown' for the teacher did not have the corresponding experiences from

which the concept arose, except to say that it replaces a number. It appears therefore that with other sub-concepts pertaining to the concept of variable not apparently evident, it can be inferred that the teacher's understanding of the concept would be adversely affected and would hence have an impact also in her selections of the learning support materials.

The teacher's understanding of the concept of variable appeared to be more in terms of the substitution of numbers by letters which are called 'placeholders' or 'unknowns' as defined in the learning support materials used by the teacher. The teacher seemed to view these unknowns in turn as objects to be worked out so that they come back to be in the form of numbers again such that the process takes the following form:



In terms of the substitution or the replacing of number by letters which are called unknowns the following utterance captures that notion: "… if I can make maybe a typical example: if you go to shop, maybe there is a certain amount of product is *x*-amount…" Here the number that represented the amount of the product is simply replaced by the letter *x*.

The utterance: "…to see what is the value of *x*…" is reflective of the teacher's notion of unknowns being worked out back to be numbers again. The teacher was asked the following question relating to Questions 2 of the Questionnaire in figure 4.14: "What would you pick out in this question that will make learners to understand the concept of variable?"

2. The following question was given to learners to solve:

In Mr. Radebe's spaza shop there are 14 loaves of brown bread and 21 cans of fish. If he sells 12 loaves of brown bread at R4.00 each and 7 cans of fish at R3.00 each, how much money did he make from the sale of the two items?

Would you regard this question appropriate for your learners to solve?

Yes ☐ No ☐

Figure 4.15: *Question 2 of the Questionnaire*

The following extract reflects the teacher's response and further amplifies the interpretation that she viewed variables as unknowns that have to be worked:

T: I think that the question is quite easy. It's not a difficult question. A Grade 7 learner is able to understand a question like that. It's quite easy. Many use things that are of everyday's life: brown bread and fish. They will understand a question like that.

R: They will understand it? So would you pick out everything to teach that concept of variable?

T: Yes. Everything.

R: What would be the variables that you would pick out from there?

T: Ah. They use numbers.

R: They what?

T: They use numbers there. Like I said, it's quite easy, I mean….

R:(*interrupting*) My question is: Would you say the loaves are the variables, or the cans are the variables or the money is the variable…?

T: (*interrupting*) I think the money is the variable. Because at the end of the day they have to work out how much money.

R: Would you say the loaves are the variables? (*Teacher shakes her head*) No?

T: No. I don't agree the loaves are the variables.

R: Why would you say they are not variables then?

T: Because at the end of the day we want the question of money. They want to know how much money was used here.

R: And in what way was the money the variable?

(*interruption*)

T: Because we work with numbers and with figures. At the end of the day we want figures.

The conversation seems to be pointing to the teacher's notion that a number that is being sought or that has to be worked out by mathematical operations is what a variable is referred to. Alternatively could it be that the teacher takes the variable as what the question is seeking such that if the question was seeking for how many loaves of bread were sold, the response would have been different?

It is however apparent that teacher's understanding of the concept of variable seems to be stemming from the notion that if a number is not known then it is unknown and hence is a variable with which a letter may be used to represent it. This is captured by the following utterance by the teacher: "I think the money is the variable. Because at the end of the day they have to work out how much money…" In looking at *Mr. Radebe's spaza shop problem* the teacher's view seems to be that of introducing the x (unknown) in the equation, that is, the sum of two products such that the problem is viewed in the form:

12 loaves of bread @ R4.00 each + 7 cans of fish @ R3.00 each = x

or $12 \times 4 + 7 \times 3 = x$

The above transcript also highlights the difficulty that is encountered by those involved in translating real life issues into mathematics. The viewing of only money as the variable in the *spaza shop problem* by the teacher lends credence to arduous tasks that are faced by educators in the implementation of the curriculum. The insurmountable opportunities presented by the materials and everyday contexts in the teaching and learning of the subject are often left unexploited. I will return to this issue in the next chapter where a discussion emanating from the analysis of this data is done.

4.3.3 Teacher's views of the use of contexts in mathematics

The teacher seemed to be convinced that working with everyday experiences generally promotes the understanding of mathematics. She contended that she endeavours to include these, as much as possible, in her teaching and said that:

> ....So real life plays a very important role in maths. And that's what I always use, yeah. When I make, but it's not always, but most of the time, I'm trying to include the real life situation in maths…. ….Actually that is better that you use examples which are in class, we have examples with us. What's the use here that you talk about something that is far from them? Because now they have to imagine it. It's like to use their imagination.

Despite her strong belief in the use of contexts for understanding in mathematics, this did not translate into reality in terms of using contexts in order to promote the understanding of the concept of variable amongst the learners. The example of everyday experiences that were provided by the teacher of the price of bread at seven rands per loaf however puts credence to the notion that the expectation from the curriculum of use of context in the teaching and learning if mathematics tends to make the implementers to resort to the contexualisation of mathematics with a disregard to the reality of the context. This is analogous to what is described by Sethole (2004) as the myth of reference in which mathematical tasks are conveniently covered by a veneer of the everyday context. A loaf of bread that could costs seven rands is unusual for the majority of South Africans except,

in fairness to state that a section of supporters of one local soccer team have on more than one occasion have been witnessed displaying an unusually large loaf of bread, almost double the 'normal' size.

The following attempt to determine what contexts the teacher would or had used in teaching the concept of variable in a way that it will promote learners' understanding drew a delayed response from the teacher where she reaffirmed that she uses classroom situations and indicated money as an example she would pick in the class:

R: What do you, in terms of – I am getting back to the variables now – in real life situations, what is it that maybe you could get in introducing the concept like the *x*'s and *y*'s. What do you think of something that could be used in the real life situation? Do you think of any?

T: Explain that again…

R: What I … As you say that these contexts are very important, my question is that in terms of variables, in terms of *x* and *y*'s, what do think would be things that you would use in real life to introduce these *x*'s and *y*'s in your maths?

T: Make it a little bit clear, I don't understand the question. Make it a little bit simple.

R: To make it a little bit simple, for instance, say for example you, you have… let me get back to your example of *x*-amounts of bread, if you are buying so many *x*-amounts of bread, what price do you pay….

T: (interrupting) … Of one loaf of bread?

R: Yeah, or whatever thing that you can choose. What is it that you choose to use? Do you choose to use the bread or something else?

T: I think I would choose class situations. Because we have many learners who can use class situations. That would be especially nice because here in the class we use the situation in the class. Or situation where

they have money, they have money with them inside the class, or make examples of them in the class. Actually that is better that you use examples which are in class, we have examples with us. What's the use here that you talk about something that is far from them? Because now they have to imagine it. It's like to use their imagination.

The protracted response to the question alluded to the difficulty with which the teacher was wrestling in order to transit from context to mathematics. Despite the teacher having earlier indicated that she would use 'everything' in the *spaza shop problem* to teach the concept of variable, there appeared to be a disjuncture when she indicated later that she did not view the loaves of bread in terms of variables as capture here:

R: Would you say the loaves are the variables? (*Teacher shakes her head*) No?

T: No. I don't agree the loaves are the variables.

R: Why would you say they are not variables then?

T: Because at the end of the day we want the question of money. They want to know how much money was used here.

Although a response regarding why the loaves of bread could not viewed in terms of variable did not come forth from the teacher, it is apparent that the loaves of bread could have been discounted due to the fact that the question required a calculation of the amount of money made by the shopkeeper. The response by the teacher later in the interview, however, when she was asked how she uses money in order to relate it to the concept of variable highlights the challenge that exists in the transition from context to mathematics as captured in the following extract:

R: And in what way was the money the variable?

(*Interruption*)

T: Because we work with numbers and with figures. At the end of the day we want figures.

It is apparent in the interview that the most important and necessary transition from real life context to mathematics with regard to the concept of variable could not be accomplished by the teacher. In the earlier part of the interview the teacher responded in the following manner regarding the use of money in order to teach the concept of variable:

R: Ok. Now you indicated that money would be the least appropriate item to use in order to teach the concept of variable. Why did you say that?

T: I think money… you know from the example as I said, I can teach them all these things, by the end of the day, when you have money in your hand, we all know how to use money. But once I have to teach them *x* and *y*, that's going to be difficult. If I tell the child that listen: if I have a thousand rands, count for me that five hundred there, it is easy to count that five hundred. But if I tell the child, listen, go to do *x* plus nine minus that, that's going to be difficult for that child to do that. I don't use money, yeah. I don't use money at all.

In this utterance the teacher expressed the challenge that she faces of making the transition from context in the form of money to mathematics in terms of the concept of variable. She also highlights the difficulty that learners face in making the transition. Instead, the understanding of the concept of variable for the teacher seemed to have stagnated to the level of an unknown number being replaced by a letter called variable which it can be inferred will be used in her interaction with the learners. The issue of transition from context to mathematics is critical in the curriculum that advocates for the use of contexts in the teaching and learning of mathematics and hence it is picked up as an issue for discussion in the next chapter.

The teacher's perception for the purpose of the use of context in mathematics appears to be different from the one propagated for in the curriculum in which learners are expected to investigate and understand. This is evinced in the following extract:

R: Ok. Maybe let's go a bit away from the *x*, but we will probably come back. The RNCS also requires that whatever that you teach, you should use contexts, that is whatever that surrounds the learners, their everyday experience. How do you feel about that kind of approach in terms of mathematics?

T: Like I said it normally there, what I do normally, you are right when you say that RNCS requires the use of everyday experiences or whatever. Because when I explain something I always make an example, like I said, with a shop. When you go to shop with your mother and you buy loaves of bread, you need to know. I mean if you buy seven you don't have to count: one loaf of bread is seven rand and you have to say 7 + 7 + 7… You have to go, listen: seven loaves of bread, 7 × 7 is 49. So I always make that real life situation: "when you go to shop" and "in real life this is how I am supposed to do it". So real plays a very important role in maths. And that's what I always use, yeah. When I make, but it's not always, but most of the time, I'm trying to include the real life situation in maths and expect them to do multiplication, especially multiplication.

In indicating that learners do not need to count but to come up with an answer when encountering issues which require the operation of numbers found real life experiences, the teacher was exhibiting what research has shown that teachers have theories and belief systems that influence their perceptions, plans and actions in the classroom (Carpenter & Fennema, 1991). The teacher had indicated in the preliminary interview that she believed that multiplication is a very important operation in mathematics which learners have to be drilled in. Apparently, for the teacher, the use of contexts in mathematics relates to learners being able to operate numbers they encounter in their everyday experiences in order to put forward prompt and accurate results of those operations.

Finally the use of real life context in mathematics raises issues that become nuisance factors as it was picked up by the teacher when attempting to use learners' everyday experiences in teaching fractions.

T: So, most of the time, I try to make real life situations in the classroom when I teach fractions. I try to cut something in half… or take four learners and make

> an example, 'if you buy a pizza', I say listen, I got a full pizza and I got four boys, and I said how much each one is going to get? And the one said no I will get two slices. And I said no guys, each of you guys is going to get a quarter because a quarter plus a quarter is a half. Because if you are four….

The example used by the teacher of boys buying a pizza where one of the boys was indicating that he would get two slices of the pizza is a clear indication of how real life experiences become difficult to be expressed in mathematical ways. It is possible for instance for the boy to actually get the two 'smaller' slices just as he had expressed with the other three boys probably getting one 'bigger' slice each. The variable possible scenarios of how the boys will share the pizza are themselves insurmountable and hence making it extremely difficult to get one specific answer in consideration of how the question was expressed by the teacher. Suffice it to say, it is highly impractical for each of the boys to each get an equal quarter of the pizza. This nuisance factor of using context in mathematics is often underemphasised.

4.3.4 Using Skemp's tools of concept formation

The notion of mathematisation of everyday experiences by using examples such as pizza, bread, fish etc. for the formation of the primary conceptions of the concept of variable were not utilised by the teacher. The use of money as a sub-concept of the concept of variable was regarded as inappropriate in the teacher's questionnaire response. The letter *R*, which stands for money in the form of rands and was also depicted in the questionnaire did not elicit any recognition as the letter that may 'stand in the place of any number' on the part of the teacher. It is reasonable to infer that the same letter *R* – that in all probability is certainly depicted in the money that the teacher indicated to have used in the class on previous occasions – should have been recognised by the teacher as the letter that stands in place of the value of the money. She indicated that, as part of using everyday experiences to promote mathematical understanding, she uses money in the class situations and this is captured in the following utterance in response to the question of what contexts does she choose to use in order to teach the variables *x*, *y* etc.:

> I think I would choose class situations. Because we have many learners who can use class situations. That would be especially nice because here in the class we use the situation in the class. Or situation where they have money, they have money with them inside the class, or make examples of them in the class. Actually that is better that you use examples which are in class, we have examples with us. What's the use here that you talk about something that is far from them. Because now they have to imagine it. It's like to use their imagination.

This, however, appeared to be a contradiction with regard to her responses to the questionnaire. She contended that she does not use money as means of promoting the concept of variable by making the following utterance:

> I think money… you know from the example as I said, I can teach them all these things, by the end of the day, when you have money in your hand, we all know how to use money. But once I have to teach them *x* and *y*, that's going to be difficult. If I tell the child that listen: if I have a thousand rands, count for me that five hundred there, it is easy to count that five hundred. But if I tell the child, listen, go to do *x* plus nine minus that, that's going to be difficult for that child to do that. I don't use money, yeah. I don't use money at all.

It was also interesting, however, to note that the majority of the examples that the teacher used in the interview involved money, despite her indicating in the questionnaire that it was the least appropriate to use for the teaching of the concept of variable. The contradictions regarding the use of money as context to promote the understanding of the variable amongst learners epitomises the most important aspect of this report. In as much as the teacher realises need to use context in promoting the understanding of the concept, the means by which the transition from context to mathematics are apparently not available for her use.

Finally, considering that the teacher recognises variables in terms of letters, it was surprising that the letter *R*, which was the only letter used in the questionnaire, did not come up on the side of the teacher as an example of variable in the interview. It has to be

considered that money is not a sub-concept as its value is determined by, amongst others, the country's gross domestic product of which gold was at one stage in the past a major contributor. It is clear that in determining the value of the rand, the South African products are mathematised such that the variable letter *R* is representative of its value at a specified particular time. Money therefore presents a valuable example of promoting the linking of context to the concept of variable. In terms of using past experiences the teacher reiterated their importance while in the same breath lamenting on how their usage seemed to be absent in the classroom situations and this is captured by this utterance when referring learners' use of everyday contexts: "…And this is basics because you do these things everyday but when you have to come to class and write it… now you don't understand it." The teacher here expressed the difficulty that she experienced with her learners of making the transition from context to mathematics.

4.4 Summary of the findings

The materials that Bongi had access to were mainly using contexts to present mathematics. In terms of the promotion of the understanding of the concept of variable there appeared – despite the numerous alternate ways used in the text inclusive of number patterns, tables, the flow charts and placeholders – to be an inclination towards the development of the definition of variable. The interview done with Bongi elicited an expression that indicated an apparent contradiction on her part regarding her understanding of the concept of variable when she initially said that she had no idea of what is meant by the term variable. Despite the utterance of indicating her exclusive usage of the letter *x* amongst her learners, it could be deducted that Bongi's understanding of the concept of variable was not very far from what was presented in the materials especially in terms of viewing the variable an 'unknown number represented by a letter'. It followed from the analyses of the materials that the teacher had availed for the study, the materials she indicated to have actually used in her class as well as the interview with the teacher that the promotion of the understanding of the concept of variable by using context could have been taken much further than the way it was portrayed through the three means by which data was collected for the study. Not even the apparent positive views expressed by the teacher regarding the use of context did this

affective attitude translate to their most adequate usage in relation to the promotion of the understanding of the concept of variable.

The findings in the analysis of the data elicited an emergence of the following key issues which are taken up as the subject of discussion in the next chapter:

- With the curriculum advocating for the use of context in the learning and teaching of mathematics what does it take to make the transition from context to mathematics in terms of the promotion of the understanding of the concept of variable?
- To what extent is the adequacy of the materials to deal with issues of transition from context to mathematics in terms of the promotion of the understanding of the concept of variable?
- What opportunities, identified in this study, were available for the teacher to use context in order to promote the understanding of the concept of variable?

Chapter 5: Discussion of Findings

5.1 Introduction

In this chapter the use of context in order to promote the understanding of the concept of variable is discussed in terms of a process that I refer to as a transition from context to mathematics. Transition is viewed in this report as the formation of a meaningful link between the context used and mathematics. It has to be acknowledged that everyday context is not necessarily mathematical and therefore whenever context is used in mathematics some form of adaptation of the context is necessary so that it can take the mathematical form. The chapter therefore focuses on the challenges that were faced by the teacher in negotiating this transition, the adequacy of the materials that were at the teacher's disposal in dealing with the issue of transition as well as the opportunities that were identified as possible to be used by the teacher to transit from context to mathematics in the promotion of the understanding of the concept of variable.

5.2 What does it take by using context in the teaching and learning of mathematics to make the transition from context to mathematics?

The new South African curriculum advocates for the use of context in the teaching and learning of mathematics. Learning Outcome 2 (LO2) of the RNCS, for instance, requires that contexts "should be selected in which the learner can use algebraic language and skill to describe patterns, and relationships in a way that builds awareness of other Learning Areas, as well as human rights, social, economic, cultural, political and environmental issues" (Department of Education, 2002, p. 63). One of the Grade seven assessment standards of LO2 indicates that learners are expected to represent and use these relationships with *variables* (DoE, 2002, p. 74). This study however raises the matter of the challenges encountered by a teacher in selecting and using context for purposes of making mathematics understandable and, in particular, promoting the understanding of the concept of variable.

The concept of variable was defined in the learning materials that were used by Bongi in Unit 2.6 Activity in which the users of the textbook are reminded that: "In Grade one you used a shape to show the unknown, for example, 1 + 2 = $\square$.You can also use a letter to

stand in the place of an unknown number. For example $2 \times 4 = a$ where a is equal to 8. Another name for the unknown is variable" (Yule et al., 2005: 113). Despite the teacher being aware of numbers in mathematics where letters are used in their place, it is apparent in this study that that awareness did not translate to the teacher having an understanding as to how and from whence the letters come to represent the numbers. The following utterance captures the teacher's challenge to make the transition from context to mathematics or vise-versa:

> Yeah, there is a connection. If I can... – I don't know how to say *x* – if I can make maybe a typical example: if you go to shop, maybe there is a certain amount of product is *x*-amount, so you have to work out what how much that product is, it can take back to what that product is costing in the shop.

The indication by the teacher of 'working out the amount of the product that costs *x*-amount' is indicative of the notion of the obscuring of numbers by letters where the latter have to be 'worked out' back to numbers. The problem is supposed to be considered solved when the number that the letter *x* is standing for is determined.

The definition in the textbook as well as Bongi's apparent awareness of the use of letters in place of numbers captures by what Cangelosi (1996) contends hinders teaching and learning. Cangelosi's definition of variable as a quantity, quality or character that can assume more than one value therefore is essential in the teaching and learning of the concept by using contexts. The definition in the textbook and the teacher's notion of the concept excludes the literal meaning of the concept of variable as evinced in real life situations. The two did not however facilitate meaningful communication of the concept even though Bongi was attempting to do so with the use of context. It appears therefore that it should take more than putting up of a definition to explain the concept of variable in a way that facilitates a meaningful transition from contexts to mathematics.

The use of everyday experiences in mathematics by Bongi, in the materials that she indicated she had used in the class and even by the learners as indicated in the interview did not necessarily translate to the required transition from contexts to mathematics and

this is captured in the following lament by the teacher: "… and this is basics because you do these things everyday but when you have to come to class and write it, and say a quarter plus a quarter, you say no, a quarter and a quarter gives you one. But I said: "but guys you do these things practically, now you don't understand it!" The extract captures Wijers and van Reeuwijk's (2004) description of learners using temporary mathematical actions which are not fully formed.

It is significant therefore to point out that it will take more than the usage of contexts themselves to promote the transition that is under discussion in this section. The teacher, for example, had pointed to the usage of money as one of the everyday contexts that she employs to teach mathematics in several examples that she had offered, however, the following points to the disjuncture when it comes to the transition with regard to the promotion of the understanding of the concept of variable:

T: (*interrupting*) I think the money is the variable. Because at the end of the day they have to work out how much money…

R: Would you say the loaves are the variables? (Teacher shakes head) No?

T: No. I don't agree the loaves are the variables.

R: Why would you say they are not variables then?

T: Because at the end of the day we want the question of money. They want to know how much money was used here.

R: And in what way was the money the variable?

(*Interruption*)

T: Because we work with numbers and with figures. At the end of the day we want figures.

When asked: “In what way was the money the variable?”, Bongi resorted to the number-unknown-number approach and the issue of transition was therefore not entertained. She had indicated earlier in the questionnaire that the *spaza shop problem* was appropriate to be used in the teaching and learning of the concept of variable to the Grade 7 learners and subsequently described the question in the interview as ‘quite easy’ for the learners to understand. The appropriateness and the easiness of the problem however did not translate to meaningfully linking money to the concept of variable for the teacher, pointing to the challenge that has already been identified.

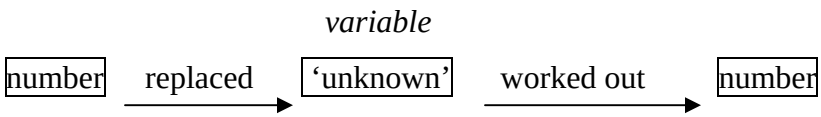
Suffice it to say, the stipulations in the curriculum for the usage of contexts in the teaching and learning of mathematics is no guarantee for the transition and this is evinced in the teacher’s awareness of this curriculum requirement:

> …you are right when you say that RNCS requires the use of everyday experiences or whatever. Because when I explain something I always make an example, like I said, with a shop…. So I always make that real life situation: “when you go to shop” and “in real life this is how I am supposed to do it”. So real plays a very important role in maths. And that’s what I always use, yeah. When I make, but it’s not always, but most of the time, I’m trying to include the real life situation in maths and expect them to do multiplication, especially multiplication.

Haimes (1996) found that teachers’ pedagogical practices were overshadowed by their previous experiences and it is evident in this situation that the intended curriculum did not take prominence over the teacher’s belief that “learners have to know their tables” in order to do mathematics. The stipulations in the curriculum are therefore also not sufficient to make the transition. This finding points to the need for filling the gap that is apparently in existence when it comes to the relationship between the intended and the implemented curriculum in addressing, amongst other factors, the teacher’s beliefs and previous experiences .

Bongi’s understanding of the concept of variable influenced her selection and usage of the materials. As already discussed in the data analysis, the teacher’s understanding of the

concept of variable appears to be more in terms of the substitution of numbers by letters which are called ‘placeholders’ or ‘unknowns’ as defined in one of the learning support materials that she was using. The teacher seemed to view these unknowns as objects to be worked out so that they come back to be in the form of numbers again such that the process takes the form:



The assessment activity 3.6 parts 1, 2, 4 and 5, for example, points to this interpretation as in all cases the letters in the activities will be replaced eventually by numbers. The viewing of variables in terms of placeholders in the curriculum as well as in the materials used by the teacher is evident in the selection of activity 12 of assessment activity 4.1 as well as activities 4 and 5 of assessment activity 5 and 6 where asterisks (*) are used. Stoffels (2005) identified teacher’s selection of curriculum materials in terms of texts steering content selection. Although it was not apparent in this study as to what informed the teacher’s selection with regard to the implementation of the new curriculum it however be inferred that since the teacher had undergone only one in-service training for implementation in Grade 6 and none for Grade 7, she was under-prepared for the pedagogical shifts of the new curriculum.

The association of the concept of variable with the term *unknown* number, however, brings about a dimension that warrants a discussion. The term *unknown* might not be representative of a number that is unknown to the reader. The number that is supposed to be placed in the placeholder $\square$ in the sum $1 + 2 = \square$, for example, is in all probability not unknown to the majority of Grade 7 learners. Calling this number an unknown may therefore sound a bit misleading for these learners and therefore it may be necessary to highlight this issue in the promotion of the understanding of the concept of variable when the term of unknown is used.

In the previous chapter (Data Analysis) it was shown that this transition was possible through the notion of mathematisation. As already stated, by mathematisation, reference

is made to the notion found in Etten and Smit (2005) of the translation of contexts into mathematics such that the subject matter should be experientially real for the learners thus acting as the launch pad for initial stages of concept formation as indicated by Skemp (1981). The notion of mathematisation therefore posits itself as a very important tool in the transition from context to mathematics in as far the promotion of the understanding of the concept of variable is concerned.

Skemp (1981) suggests that in order to form a concept, the selection and composition of suitable examples require inventiveness and a very clear awareness of the concept to be communicated. This is made possible by firstly making sure that before trying to communicate a new concept it is necessary to find out its contributory concepts until either the primary concept or experience which may be assumed as 'given' is reached. Secondly the contributory concepts needed for each new stage must be available. It is apparent that although the contributory concepts for the different stages of the formation of the concept of variable were not only available but acknowledged to be necessary by the teacher, she did not have adequate awareness of the concept and could not use the contributory concepts until reaching the primary concepts or experiences that could have been assumed as 'given' for the promotion of the concept of variable.

5.3 To what extent is the adequacy of the materials to deal with issues of transition from context to mathematics?

The materials that Bongi provided in the study for analysis point to the potential for adequacy. In the assessment activity 3.6, for example, the potential for the use of past experiences in the form of arithmetic where in parts 1 to 5, the learners' knowledge of addition, subtraction, multiplication and division of numbers could be employed is significant. In all the instances the variability - an essential sub-concept of the formation of the concept of variable - of the numbers that are to be substituted in the closed sentences is apparent. The definition of variables as 'letters used in the place of number' and the apparent notion of place holders captures the concept of variable in terms of their substitutive function of the numbers to be used in their places.

The use of trees of varying heights in activity 6 of the same assessment activity 3.6 also points to the use of past experiences assumed to be there for learners. This was suggested by Skemp (1981) as an important aspect in the formation of a concept. In terms of activity 3, the concept of whole number firstly renders the formation of the concept of variable possible where the former can be used as a higher level formation in the process of the latter's conception. The use of variables as a general representation of whole numbers gives credence to the notion of viewing algebra as generalised arithmetic since the understanding of whole numbers together with the order of their sequencing has the potential of illuminating the general form of the representation of whole numbers, as suggested by Lin and Kaput (2004). In all the activities 1 through to 5 the use of letters serves as the common feature necessary for the formation of the concept of variable, which depict in a sensory way or by sight, examples of what is generally referred to as variables. This rendered the materials to be in line with what is suggested by Wijers and Van Reeuwijk (2004) that the introduction of variable should be such that learners can operate with it at a concrete and informal level.

In assessment activity 3.7 the issue of conversions and substitutions of everyday experiences with different units of measurement captures the conception of the concept of variable in a profound manner. As already discussed in the previous chapter, variable measurements of weights, for example, may be converted and/or substituted with a variety of different units of weight. This can serve as a good platform for launching the understanding of the concept of variable. The use of the quantity of time in parts 5 to 8 provide further examples of conversion and substitution but also brings forth the reality that the units that are used for quantifying time are themselves not necessarily the same in quantity where the examples of months as 28, 29, 30 or 31 days and years as either 365 or 366 days come to the fore and the sub-concept of variability is once more highlighted. All this point to how contexts are transitioned into mathematics where the '*what* and *how much* or *how many*' are the focus of attention. The conversions and substitution of everyday experiences is referred to by Van den Heuvel-Panhuizen (2005) as the

characteristic of a task presented to learners, where words and pictures that help learners' understanding of the task take prominence.

The tendency to dissociate numbers from the everyday experiences they originate from, especially after the occurrence of the process of abstract conceptualisation of the concept of number, needs to be reassessed. Despite the fact that in the early stages of learning mathematics the use of everyday experiences in the formation of the concept of number is mandatory to say the least, the concept of number is in the latter years of learning presented as devoid of past experiences that were used for its formation. It is striking to note that, at times, the dissociation between numbers from their everyday experiences is, in some instances, difficult to achieve. Any dissociation of the number from the unit where it originates, viz. the everyday experience, results in number not depicting the object it quantifies or qualifies and will hence not convey the original meaning. When quantities, qualities and/or characters such as age, mass, length, money, time and volume are mentioned their respective units in the form of year, gram, metre, rand, hour and litre are always in close attendance such that the number which is representative of how many/much the units are is normally placed on the left of the quantity, quality and/or character that is measured or counted, for example, 2*yrs*, 5*g*, 7*m*, 4*hrs* and10*l*. The exception in this case is terms of money where, for example, the unit *R* in five rands (*R*5) is written on the left even though it is pronounced as 'five *rands*', in consistency with how the others are also pronounced. Incidentally, the writing of money in the form *R*5 is consistent with how it is pronounced in the South African indigenous languages in which the units are pronounced ahead of how many/much the measured or counted units are, for example, *R*5 in SeTswana is be pronounced as "di-*ranta* tse tlhano" while in IsiZulu it is pronounced as "ama-*randi* a mahlanu".

To take this matter further, suppose an apple is shown and we are asked to indicate how many apples are there, the expected answer to this scenario would be the pronouncement of 'one' and this may be represented mathematically as 1. In the same way an orange can represented mathematically as 1. If these 1's are taken to be added together, the sum will be represented as 1 + 1. If this sum is given to anyone who knows how to add numbers

but was not aware of the scenario described here, it can be expected that the person will put forward the answer of 2. It should be recognised that such a person will probably be using the base ten (b-10) system and also using the assumption that there is no difference between the stated 1's, meaning that 1 – 1 = 0. There can be no denying the impossibility of the taking away or the subtraction of an orange from an apple or vice-versa! The abstraction of the concept of number however makes it possible to dissociate numbers from their origin. The unintended consequence of this development is the tendency to hide away the sameness of the numbers, the mandatory requirement in the addition of number in mathematics, where it is always possible to distinguish if numbers are not dissociated from where they originate. At present, if 1 is added to another 1 and we get 2, the assumption that both 1's are the same is often taken for granted and is always taken as a 'given'.

It should be noted, however, with the numbers originating from the quantifying of everyday experiences, that no more than one everyday experience is necessarily exactly the same as the other one and hence everyday experiences are inherently variable. It is through the process of mathematisation that the quantifying or qualifying of everyday experiences is possible which would not have been the case if the accurateness and exactness – the fundamental requisites in mathematics operations – are considered.

Furthermore, in a number such as 12, which is representative of 1 ten and 2 ones when using the b-10 system, it can and is normally assumed that there are ten 1's in the digit 1 and these 1's are the same as the two 1's in the digit 2. It should be recognised that the b-10 system makes it possible to write the numbers without indicating what they represent as these are captured by the positions where these digits are placed in the system. I should be quick to add that the use of unit in this instance is different to the standardised usage of the term which is indicative of the 1's. The units referred to here are indicative of the different digits in terms of their placing in the b-10 system such that ones, tens, hundreds, tenths, thousandths etc. are identified as different units. It should be noted that the b-10 system works in such a way that any 10 same elements of a particular unit are represented by a new unit, for example, 10 tens are represented as 1 hundred. This is characteristic of

the b-10 system. This is also analogous to the system used in the quantifying of time where 60 seconds are representative of 1 minute. The meanings of the numbers themselves can therefore not be dissociated from the context where they originate as shown here with the b-10 system. The fact that the hundreds (3), tens (5) and the ones (7) in the number 357 are not individually identified as such should not detract from the reality that they are in fact identified in terms of the position of the digits in the b-10 system, otherwise we could be seeing 3 hundreds, 5 tens and 7 ones or 3h, 5t and 7o or, to get closest to the depiction of the sum of unlike terms, 3h + 5t + 7o.

The discussion here is in no way undermining the importance of the abstraction of the mathematical concept of number but it is meant to strengthen the conception of the concept of variable. Skemp (1981) indicates that increased noise is necessary for the establishment of the strengthened abstract conceptualisations which in turn reduce the learner's dependency on the teacher. I therefore regard the discussion above as the necessary noise.

In the depiction of fractions as representative of parts of a whole and recognising the impossibility of practically accurately dividing any real life object into exactly the same equal parts the identification of the different fraction units shown in assessment activity 3.7 part 2a where $4 + {}^{8}/_{10} + {}^{6}/_{100} + {}^{2}/_{1000}$ (Yule et al., 2005: 208) is to be represented in decimal form as 4,862 as required by the b-10 system, signifies the importance of variables in making sense of parts of real life objects in a mathematical way. This is in recognition that the closest we can manage to get 2 hundredths in real life situations from 2 same and equal parts would be by having added exactly the same 1 hundredths, which is impossible. It is here where the concept of variable is able to fill in the gap that would have otherwise existed considering the accuracy that is associated with mathematics in relation to what happens in our everyday experiences.

In part 12 of assessment activity 4.1 the use of place holders which are conventionally regarded as the items that are replaced by letters that are called variables in the learners' development of mathematics highlights the issue of the use of past experiences which

may be assumed as ‘given’. The importance and the necessity of placeholders is often overlooked. If we take for instance the statement ‘3 + = 5’ the necessity of depicting the space between the plus and the equal signs cannot be overemphasized, for the statement looks more understandable in the form ‘3 + □ = 5’. The use of the letter *x* to represent the shape so that it reads ‘3 + *x* = 5’ however allows for a better verbalization of the statement. The significance of being able to use any of a variety of letters for this purpose also needs to be emphasised in the formation of the concept of variable.

The importance of the depiction of non-examples in the formation of the concept of variable was not apparent in the materials that the teacher provided for analysis. Skemp (1981) states that the formation of a concept requires a number of experiences which have something in common while at the same time highlighting the importance of contrasts and of non-examples which make the similarity between members of a particular classification more noticeable. In activity 3 of assessment activity 4.2 an experience for contrasting is provided as evident in the example $5 + 5 + 5 = 3 \times p = q$. Although the answer *q* is depicted by a single letter, it is representative of a two digit number 15. These kinds of contrast are necessary considering that there could be variables such as in *xy* where representation of $x \times y$ is depicted whereas there could also be the example of *kg* in which the representation of the unit of weight called kilogram is depicted. The important sub-concept of variability is evident in the variable possible answers that could be provided by learners as shown in activity 1 of assessment activity 3.6 and is captured clearly in unit 4.6 where it is stated that: “The correct name for letters which stand in the place of numbers is *variables*. This is because a letter can have various values, for example, $1 + a = 3$, where *a* equals 2, while in $8 – a = 7$, *a* equals 1” (Yule et al., 2005 :250).

Most of the materials provided by Bongi for analysis therefore, in conclusion, had great potential in terms of their adequacy to deal with the issue of transition from context to mathematics for the promotion of understanding of the concept of variable. It also comes as a matter of interest to note that the concept of variable offers itself a tool through

which the process of mathematisation is enacted and hence the means by which transition from everyday context to mathematics is facilitated.

5.4 Opportunities identified as possibly available for use of context by teacher in order to promote the understanding of the concept of variable

The teacher was provided with opportunities in no less than three instances in the interview in which to communicate the translation of the contexts she had selected into mathematics in the pursuit of the promotion of understanding of the concept of variable. The following extract highlights the extent to which the opportunities were exploited by the teacher.

R: (*interrupting*) My question is: Would you say the loaves are the variables, or the cans are the variables or the money is the variable…?

T: (*interrupting*) I think the money is the variable. Because at the end of the day they have to work out how much money…

R: Would you say the loaves are the variables? (*Teacher shakes her head*) No?

T: No. I don't agree the loaves are the variables.

R: Why would you say they are not variables then?

T: Because at the end of the day we want the question of money. They want to know how much money was used here.

R: And in what way was the money the variable?

(*interruption*)

T: Because we work with numbers and with figures. At the end of the day we want figures.

Despite the teacher resorting to the familiar number-unknown-number approach in terms of the use of money as context, the opportunity to possibly highlight the loaves of bread as variables that are priced the same – notwithstanding their possible inherent variability in terms of size and quality – was not seized. The viewing of the amount of money for the selling of brown bread could also, for instance, be seen in terms of a function. Blanton and Kaput (2005) had identified generalised arithmetic and functional thinking as the two forms of algebraic reasoning commonly used in elementary grades and this presented an opportunity to be exploited by the teacher. With money collected for the sold bread as the dependent variable (C or $c(b)$), the number of loaves of bread sold as the independent variable (b) and the price of the bread as the rate of increase (p), the function could be captured as:

$$C = c(b) = pb$$

The rate of increase p remains constant in the function over a particular period of time while the C and the b are themselves variable in that period, depending on the number of loaves that were sold. It is therefore rather fascinating to notice that the p, which is a letter, is described in terms of constancy. Is a letter that stands for a number, and is therefore referred to as a variable, also a constant? Or is a constant also a variable?

The example of using common features as suggested by Skemp (1981) in the formation of a concept seems to be a little far-fetched for the analysis of exploring how the promotion of understanding of the concept of variable was done by selection of context by the teacher, however the importance of sameness in mathematics operations cannot be overlooked. The opportunity that presented itself in the spaza shop problem in the form of the common feature of money with regard to bread and fish was not realised. The prices of brown bread and fish being R4.00 and R3.00 respectively require re-presentation in the form:

4.00 rands(r) per bread(b) and 3.00 rands(r) per fish (f) respectively

or $4.00^{r}/_{b}$ and $3.00^{r}/_{f}$

and thus $12b \times 4.00^{r}/_{b}$ and $7f \times 3.00^{r}/_{f}$ (not common)

$= 12 \times 4.00\ b(^{r}/_{b}) + 7 \times 3.00\ f\ (^{r}/_{f})$ (not common)

$= 48.00r + 21r$ (common)

The above example emphasises the rule that is traditionally put forward without explanation in the operation of variables of the addition or subtraction of only like terms. It needs to be noted how the sum of the items together with their unit prices come to be an operation involving common variables which would not have happened considering uncommonness regarding bread and fish and their respective unit prices. The discussion on the addition of only the like terms also brings to the fore the issue of the "fruit salad algebra" highlighted by Wijers and Reeuwijk (2004). In discouraging the use of fruits like apricots and peaches in explaining the operation of variables such as $a + p$, the convenient disregard of the existence of juices in real life contexts where the combination of such fruits is possible, is conspicuous by its absence on such deliberations by curriculum experts and teachers. Without having to go into the practical details of how many apricots or peaches are required to come up with such a juice it can be acknowledged that particular numbers of the said fruits are needed to produce a particular unit that is bottled for consumption. It could require, for example 7 peaches (p) and 12 apricots (a) to make ½ litre of the juice. The variable amounts of litres produced by each fruit for the juice mark opportunities for elaboration on the formation of the concept of variable. The fact that there are seven peaches and twelve apricots should not override the reality that each peach will provide a particular amount of the juice such that the juice can be represented as:

$$p_1 + p_2 + p_3 + p_4 + p_5 + p_6 + p_7 + a_1 + a_2 + a_3 + a_4 + a_5 + a_6 + a_7 + a_8 + a_9 + a_{10} + a_{11} + a_{12}$$

where p_n = amount in litres of a particular peach and

a_m = amount in litres of a particular apricot.

The variable fruits p_n and a_m are mathematised into a common unit of measurement, namely litre, making it possible that a juice called peach-apricot can be produced. It should be recognised also that despite the inherent variability of the fruits it is possible also to quantify the fruits that produce the ½ litre of the juice. Therefore not only is $p_1 + p_2 + p_3 + p_4 + p_5 + p_6 + p_7 + a_1 + a_2 + a_3 + a_4 + a_5 + a_6 + a_7 + a_8 + a_9 + a_{10} + a_{11} + a_{12} = ½$ litre, where each fruit is mathematised into the common unit of litre, but $7p + 12a = ½$ litre also, where the mathematisation of the variable fruits is exercised.

Units that are used for quantifying real life objects and experiences such as grams, metres, minutes *etc.* are often disregarded when examples of variables are sought. It is however interesting to note that when such objects or experiences are talked about in terms of their quantity, they are treated in exactly the same way the variables are treated in mathematics. To illustrate this point, in the sums, $3g + 2g = 5g$ and $4g + 4m = 4g + 4m$, the only differentiation between the units of measurement and variables is only possible if one is informed that *g* stands for grams and *m* for metres. It is significant to note how rules would not be required to do the sums once one is informed that the letters stand for units of measurement as indicated in the example. The opportunity to promote understanding of the concept of variable in this manner was possible in the assessment activity 3.6 parts 4 to 8 as well as assessment activity 4.3.

5.5 Conclusion

A consequence of Skemp's second principle of concept formation is that if a particular level is imperfectly understood, then everything from then on may be in peril. This is the kind of dependency that exists in mathematics but is conspicuous by its absence in other learning areas. This situation however is not irremediable as stated by Skemp who indicates that back-tracking is possible by the provision of a genuine explanation. It is therefore encouraging to note that the reversibility of this situation is possible as it means that whatever mishaps that had resulted from learners' lack of or partial understanding of the concept of variable are not permanent and may be corrected.

CHAPTER 6: Conclusion

6.1 Summary of the findings

This study explored how a teacher selects contexts from learning support materials with the aim of promoting understanding of the concept of variables amongst learners. In-depth analyses were conducted on the teacher's materials together with those that the teacher used in her class as well as interviews with the teacher. Based on this analysis, I turn to answer the critical research questions for the study.

6.1.1 Critical research questions

The following were critical questions for this research:

a. What contexts are selected by the Grade 7 teacher to promote understanding of the concept of variable and why?
b. How are the selected contexts intended to be used by the teacher in order to promote understanding of the concept of variable?
c. To what extent do the contexts selected for use have the potential to promote understanding of the concept of variable?

a) Contexts selected by Grade 7 teacher and why they were selected

The contexts that Bongi selected for the teaching and learning of the concept of variable were largely not incongruent with how they were depicted in the learning support materials in which the obscuring of number, of which value has to be determined, is done by means a placeholder or letter. She indicated a preference to using classroom situations in her teaching and learning the concept of variable however in terms of promoting its understanding the analysis of data elicited an inadequacy of the means by which that could be accomplished by her. It is envisaged that the new curriculum will provide teachers with opportunities to manipulate whatever it is they find in the learning materials so as to exploit the environments that they are based at in order to enhance learners' understanding of mathematics. It transpired, however, that this could not materialise as there appeared to be a gap that existed between the contexts that are used and the intended understanding of mathematics. The findings by Stoffels (2005) that identified

curriculum texts as steering content selection for teachers is given credence in this study in that not only did the teacher's preference for texts that 'showed the steps' not prevent Bongi from using the materials that did not meet this criterion but the texts that she selected were used unaltered as it is depicted in the assessment activities that she presented to the learners.

The bulk of the contexts selected by the teacher were largely those found in the learning support materials (LSM) despite the teacher's indication that she uses classroom situations, for example the money possessed by learners in the class. It is apparent that the teacher's inadequate training on the pedagogical shift required for the implementation of the new curriculum namely, use of context in the teaching and learning of the mathematics, influenced the teacher's LSM-biased selection.

b) Teacher's use of the contexts in a manner that promotes understanding of the concept of variable

The combination of the use of contexts in the learning support materials together with their use by teachers in the teaching and learning practice of mathematics is meant to enhance the understanding of the subject. This synergy however was not apparent with regard to the data gathered in this study as there appeared that the issue of mathematisation could not be successfully negotiated both in the learning support materials and by the teacher. It is fair to suggest that in terms of the teacher's presentation of fractions to learners the intention of mathematisation with regard to the sharing of pizza by the four learners was apparent. It was evident in the interview however that due to the problem of transition from context to mathematics that proved to be an elusive endeavour.

One of the most frequent ways of the use of everyday contexts in mathematics is that of solving the mathematical issues arising from contexts. This kind of use is however not always possible resulting in practitioners contexualising mathematics by disguising the mathematics intended to be presented with the everyday context. This is what is described by Sethole (2004) as the myth of reference in which mathematical tasks are

conveniently covered by a veneer of the everyday context. The example that props up with regard to the myth of reference is the one in which the teacher was referring to product that cost *x*-amount had to 'worked out' to the price of the product. This example is also indicative of the teacher's perception of the concept of variable in terms of the replacement of numbers found in the contexts with the letters.

Despite the enormous potential of the contexts in the LSM as well as those selected by the teacher in order to promote understanding of the concept of variable, there appeared to be an inadequacy by both on their use due to mainly non-mathematisation. The manner in which the teacher used the selected contexts in the LSM left a sizeable field of un-chartered ground that appeared to be there for the taking. This report has highlighted the extent to which this was possible.

c) Potential of selected contexts to promote learner's understanding of the concept of variable

The contexts presented in the learning support materials had the potential to promote understanding of the concept of variable. The possibility of promoting the understanding in view of the adequacy of the learning support materials however could be exploited by the teacher. As already discussed in the preceding chapter, the use of money as context, for instance, was appropriate as it covered the different levels for the formation of the concept of variable. Not only were the necessary experiences for the formation of the primary concept available but the formation of the sub-concept of variability was also possible. This was in consideration that not only the variable pricing of products was possible but the variable values that could be placed on the money itself, where the rate of money exchange could be used as an example, were also achievable. Using the rate of money exchange as an example, suppose an American tourist, visiting Cape Town, is in possession twenty American dollars and intends to buy a product costing R140.00 in Johannesburg. If the rate of exchange is R7.00 per dollar whilst the tourist is in Cape Town but changes to R6.99 per dollar by the time she lands in Johannesburg, it follows that she would need more than her twenty dollars – which would then be worth R139.80 and 20 cents short off the price – to be able to afford to buy the product. Suffice it to say,

the volatility of this exchange rate would leave the tourist unaffected in a similar manner had she been back in her home country. It makes perfect sense to suggest that the importance using the symbol $ for the variable value of the dollar in America for our valued tourist is the same as what the symbol *R* – for the value of the rand – is for a South African. Our notes do not have to be regularly changed as the value of the rand changes. This is one aspect of variables that needs to be highlighted. The variability of variables is important and necessary.

6.1.2 Reflections on the use context

The advantages of using context in the teaching and learning of mathematics have been advocated for in the curriculum at the expense of overlooking the preparation of the teachers on how to negotiate the important aspect of transition from context to mathematics.

The variability of contexts precludes them from what is considered in the mainstream as characteristic of mathematics. Accuracy and exactness are very important in mathematics and inaccuracy is not associated with it. This can be described better in terms of Bernstein's (1982) construct of classification which is described as the degree of boundary maintenance between contents and is as the 'division of labour of educational knowledge' (p. 159). The stronger the classification the more sharply is the boundary between the contents drawn. This strong classification also reduces the power of the teacher over the knowledge that is to be constructed. It is apparent that the intention of the new curriculum in advocating for the use of context is meant to reduce these boundaries. It has to be recognised however that it is not only improbable to obtain objects in the everyday context that are equal to one another but quantifying or qualifying them in terms of accuracy and exactness is also highly unlikely. But, with these being the principles that classify mathematics from other subjects, it follows that variable contexts would have no place in mathematics. This research report suggests otherwise. Not only is the notion of mathematisation viewed as the means by which the boundaries can be

weakened but the concept of variable is propagated as the means by which the link between context and mathematics is identifiable.

6.2 Recommendations

6.2.1 Developers of mathematics learning support materials

It is apparent that the learning support materials that were at the teacher's disposal had contexts that had the potential to promote the understanding of the concept of variable as it is evident in the analysis and discussion chapters of this report. What was ostensibly conspicuous by its absence was the transition from the contexts used to the mathematics intended to be conveyed. This study was concentrating on the promotion of the understanding of only one concept, viz. the variable, and therefore the onus is on developers of mathematics learning materials to look at ways in which the transition can be addressed in the materials that are produced. The challenges with regard to the use of contexts in the promotion of understanding of the mainly abstract concepts that are encountered in mathematics are obviously insurmountable but it should be acknowledged that the notion of transition is a necessary route through which contexts can find their way into mathematics.

It should be acknowledged however that the way teachers use mathematics learning support materials is influenced by other issues such as their beliefs, previous and personal experiences, theories as well as environments where they are based. It may advantageous to develop learning support materials that seek to address these extraneous factors. One of the ways of addressing these factors may be, for instance, by anticipating and highlighting these factors in the materials with the aim of moving the users of the materials from where they are at to where the materials seek to take them.

6.2.2 Teacher education and development

The issue of the use of contexts in the teaching and learning of mathematics has implications for teacher education and development. In terms of the promotion of understanding of the concept of variable it apparent that notion of mathematisation was

not only unfamiliar for the teacher but tended to portray itself as the distance between the implemented and the intended curriculum. The only thing that captured the desperation that engulfed me during the research with regard to how I felt how near and yet how far the teacher was in cracking the code of transition from context to mathematics is the game that we used to play in my early years. The game involved one person hiding a belt and the others having to find it. The one who hid the belt had to indicate to how far they were from the belt. When one was nearest to the belt the hoarder would shout loudest: "Warm!" (the Afrikaans version). The one who finds the belt first beats up the rest of the people in the game with the treasured find. I could not help it but to imagine the teacher being the seeker but always ending up on the wrong end of the belt. As much as I felt like screaming: "warrrm!" it was apparent that the notion of mathematisation always beat the teacher to the finding of the treasure. The notion of mathematisation should therefore be considered as an important tool to be used by teachers in training as well as those that are already in practice.

It is apparent that the RNCS training that this particular teacher underwent left her with uncertainty in terms of how to enact the curriculum with regard to the selection and use of context in mathematics. It therefore becomes apparent that training that focuses not only on how teachers have to select and use contexts from the learning support materials – as a 'guide' – but adapting them to environments that their learners are at is also imperative. Van den Heuvel-Panhuizen (2005) identifies the *learning environment* as one the ways of looking at the use of contexts in educational settings. For instance, if the context used in the learning materials is the shopping mall this will not be well received by learners in the rural areas, where ordinary typical shops themselves are a scarcity.

6.2.3 Research

Even though it was found that texts steered the content selection on the teacher it is a matter that requires further investigation that the teacher's PCK in relation to the understanding of the concept of variable could apparently not be enhanced by the materials that were at the teacher's disposal to the level at which the materials intended

even when the teacher had actually used the them in her learning and teaching. The initial response of the teacher indicating that she had no idea of what was meant by the concept of variable epitomises the urgency of the investigation that is propagated for in this report.

One of the matters that require investigation is to what extent, if any, does the selection and use contexts in the way as envisaged in the curriculum promote understanding of mathematical concepts.

6.3 Reflections on the research process

The rigorous planning that was undertaken for this research nearly came to nothing when the teacher indicated that she had no idea of what is meant by the term variable. This was despite three previous meetings in which the purpose of the research was explained to the teacher. There can never be any kind of pre-planning for such kinds of responses however it is imperative to probe further should one encounter such reactions as that might shed light to what one is investigating or exploring.

In the process of analysis there appeared to be issues that needed to be revisited with the teacher. However this was not possible due to the fact that the teacher obtained a promotional post at another school in a learning area not related to mathematics and therefore the benefit that was envisaged for the teacher by participating in the study could not be realised.

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Appendices

Appendix 1: Questionnaire

Dear Teacher

You are requested to complete the following questionnaire which is part of a research that is seeking to obtain information on what teachers regard as necessary and appropriate for the teaching and learning of the concept of variable. The questionnaire does not seek to determine your proficiency in teaching but your inputs with regard to what you consider as important for this topic are much valued and will be used to inform good practice.

Thank you very much in anticipation of your participation

M. M. Phoshoko (Researcher)

1. Rate the following items in terms of appropriateness for the teaching of the concept of variable? Please cross in the appropriate column for your answer by using the following scale:
    1. most appropriate
    2. more appropriate
    3. appropriate
    4. less appropriate
    5. least appropriate

Items					
interest rates	1	2	3	4	5
age	1	2	3	4	5
speed	1	2	3	4	5
time	1	2	3	4	5
shape	1	2	3	4	5
set	1	2	3	4	5
location	1	2	3	4	5
length	1	2	3	4	5
angle	1	2	3	4	5
money	1	2	3	4	5
weather	1	2	3	4	5

What other items, not listed here, would you regard as most appropriate for use in the teaching of the understanding of the concept of variable for your learners.

2. The following question was given to learners to solve:

> In Mr. Radebe's spaza shop there are 14 loaves of brown bread and 21 cans of fish. If he sells 12 loaves of brown bread at R4.00 each and 7 cans of fish at R3.00 each, how much money did he make from the sale of the two items?

Would you regard this question appropriate for your learners to solve?

Yes ☐ No ☐

Would this question allow the teacher to check if learners understand the concept of variable? Yes ☐ No ☐

Give reason(s) for your answer?

Reason(s)

3. The following is the response of a learner who was asked to identify the following as either constant or variable.

Zandile Nkosi	constant
rectangle	variable
odd number	variable
13	constant
learners in the class	variable
15 year olds	variable
15 years	constant
15 years old	constant

Would you regard this question appropriate for your learners to solve? Please provide a reason for your answer.

Yes ☐ No ☐

Reason

Appendix 2: The Interview Schedule

The introduction

This will begin with greetings, introductions and most importantly the thanking and the showing of appreciation for the participant's willingness to be involved in the study. Remind the respondent that the aim is not to seek right or wrong answers and that they should feel free to ask questions.

The possible questions to be included in the interview

- What do you understand by the term *variable*?
- What would you regard personally as important in promoting the understanding of the concept of v*ariable* among your learners?
- In your experience of working with your learners what do you envisage as the best possible approach that can promote the understanding of this concept amongst the learners? How do you enact this approach in your class?
- What would you envisage as an obstacle that may hinder the understanding of this concept amongst your learners? How can this challenge be overcome?
- What would you regard as appropriate resources that can assist in the teaching of the concept of *variable* such that understanding of the concept is promoted?
- How do you / would you use these resources?
- The RNCS requires that contexts be chosen and used in the teaching and learning of mathematics. What context(s) would be appropriate for the promotion of understanding of the concept of *variable*?
- (Other questions will be related to the teacher's responses to the questionnaire)

The Conclusion

Thank the respondents once again and the institution for granting the interviews as well as giving details of future contact and feedback concerning the analysis and the final report of the study.

Appendix 3: Permission Letter: PRINCIPAL

Dear Principal,

I am seeking your permission to conduct a research project that is part of my Masters in Education program at the University of the Witwatersrand. The aim of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners. During the research, some learners will be asked to provide me (the researcher) with their notes or classwork book for analysis. The learners whose notes or classwork books were selected may be interviewed about once or twice during the study. The interviews will be reflective, and they will be based on learners' understanding of the concept of the variable as well as what contexts promote their understanding of the concept of variable. Each interview will take no more than half an hour. In reporting on this research, I will not use their names. All records of their responses will be kept in a safe place. All this will be done in consultation with and approval of the learners' teacher.

With the teacher's permission, I would request access to all the learning support materials that the teacher will use in the teaching of the concept of variable. After or before the concept of the variable has been taught to the learners, I would like to interview the teacher in order to find out his/her views about how and what he/she selects from the learning materials for the lesson as well as about all the processes the teacher goes through in presenting the concept of variable to the learners.

It is anticipated that the school's participation in this research and in particular that of the teacher will shed light of how the use of contexts links with the understanding the concept of variable, a very important concept in algebra. This information will help us understand more about how students relate contexts with concepts and what educators need to do in order to improve the teaching of algebra in general.

I do hope that you will grant me the permission to conduct the research at your school. The name and location of your school will not be revealed in the any way and pseudo-names will be used where applicable. The participants will be informed that participation in the research is voluntary and will have the freedom to withdraw at any time they wish to. Please contact me (Mr. Moshe Moses Phoshoko, at 0824086926 or at 011 882 6327 or by email at moshephoshoko@telkomsa.net if you would like to know more about this study at any time during this research.

Thank you for your cooperation. I am looking forward to being granted the permission.

Yours faithfully,

_____

Mr. Moshe Moses Phoshoko

Appendix 4: Letter of Consent: LEARNER

Dear Learner,

I am seeking consent for your participation in a research project that is part of my Masters program at the University of the Witwatersrand. The aim of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners. During the research, you will be asked to provide me (the researcher) with your notes or classwork book for analysis.

It is anticipated that your participation in this research will make you more aware of how the use of contexts link with the understanding the concept of variable, a very important concept in algebra through your teacher. This information will help us understand more about how students relate contexts with concepts and what educators need to do in order to improve the teaching of algebra in general.

Your participation in this research is voluntary. If you agree to participate, you will be free to withdraw from the project at any time during the study. I do hope that you decide to participate. Your participation will be adding important ideas to the learning of the concept of variable, and to this study. If you agree to participate, please complete the consent form below and return it to me. Please contact me (Mr. Moshe Moses Phoshoko, at 0824086926 or at 011 882 6327 or by email at moshephoshoko@telkomsa.net if you would like to know more about this study at any time during this research.

Thank you for your cooperation.

Yours faithfully,

_____

Mr. Moshe Moses Phoshoko

CONSENT FORM (LEARNER)

I, _____, (please print full name) hereby agree to be a participant of the research to be undertaken by Mr. Moshe Moses Phoshoko. I understand that the purpose of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners.

I acknowledge that

- the aims, methods, anticipated benefits and consequences of the research, have been explained to me.
- I voluntarily and freely give my consent to my participation in such research study.
- I understand that results will be used for research purposes and may be reported in teacher and academic journals.
- I am free to withdraw my consent at any time during the study.

I also give consent to: (Please tick the appropriate column)

	Yes	**No**
The use of and/or production of copies of my notes or classwork book of the lesson on the concept of variable.		

Signature: _____ Date: ___/_____/_06_

Appendix 5: Letter of Consent: PARENT

Dear Parent/Guardian

I am seeking consent for the participation of your child/ward in a research project that is part of my Masters program at the University of the Witwatersrand. The aim of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners. During the research, your child/ward will be asked to provide me (the researcher) with notes or classwork book for analysis. The selection and collection of the notes will only take place only in agreement with their subject educator. It is anticipated that the learners' participation in this research will make them more aware of how the use of contexts link with the understanding the concept of variable, a very important concept in algebra. This information will help us understand more about how learners relate contexts with concepts and what educators need to do in order to improve the teaching of algebra in general.

Your child's/ward's participation in this research is voluntary. If you agree to grant permission for your child or ward to participate, your child or ward will be free to withdraw from the project at any time during the study. I do hope that you will grant the permission for your child/ward to participate. Your participation will be adding important ideas to the learning of the concept of variable, and to this study. If you agree to the participation, please complete the consent form below and return it to me. Please contact me (Mr. Moshe Moses Phoshoko, at 0824086926 or at 011 882 6327 or by email at moshephoshoko@telkomsa.net if you would like to know more about this study at any time during this research.

Thank you for your cooperation.

Yours faithfully,

_____

Mr. Moshe Moses Phoshoko

CONSENT FORM (PARENT)

I, _____, (please print full name) hereby agree to be a participant of the research to be undertaken by Mr. Moshe Moses Phoshoko. I understand that the purpose of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners.

I acknowledge that

- the aims, methods, anticipated benefits and consequences of the research, have been explained to me.
- I voluntarily and freely give my consent to my participation in such research study.
- I understand that results will be used for research purposes and may be reported in teacher and academic journals.
- I am free to withdraw my consent at any time during the study.

I also give consent to: (Please tick the appropriate column)

	Yes	**No**
The use of and/or production of copies of my child's/ward's notes or classwork book of the lesson on the concept of variable.		

Signature: _____ Date: ___/_____/_06_

Appendix 6: Letter of Consent: EDUCATOR

Dear Educator,

I am seeking consent for your participation in a research project that is part of my Masters program at the University of the Witwatersrand. The aim of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners. During the research, some learners will be asked to provide me (the researcher) with their notes or classwork book for analysis. The learners whose notes or classwork books were selected may be interviewed about once or twice during the study. The interviews will be reflective, and they will be based on learners' understanding of the concept of the variable as well as what contexts promote their understanding of the concept of variable. Each interview will take no more than half an hour. In reporting on this research, I will not use their names. All records of their responses will be kept in a safe place.

With your permission, I would request access to all the learning support materials that you will use in the teaching of the concept of variable. After or before the concept of the variable has been taught to the learners, I would like to interview you in order to find out your views about how you went about you would go about in selecting and using the learning materials for the lesson, how you found or will find the materials in terms of meeting the expectations of the lesson, how the lesson was or will be sequenced, and your perceptions about learners' understanding or problems relating to the concept of variable.

It is anticipated that your participation in this research will make you more aware of how the use of contexts link with the understanding the concept of variable, a very important concept in algebra. This information will help us understand more about how students relate contexts with concepts and what educators need to do in order to improve the teaching of algebra in general.

Your participation in this research is voluntary. If you agree to participate, you will be free to withdraw from the project at any time during the study. I do hope that you decide to participate. Your participation will be adding important ideas to the learning of the concept of variable, and to this study. If you agree to participate, please complete the consent form below and return it to me. Please contact me (Mr. Moshe Moses Phoshoko, at 0824086926 or at 011 882 6327 or by email at moshephoshoko@telkomsa.net if you would like to know more about this study at any time during this research.

Thank you for your cooperation. I am looking forward to working with you.

Yours faithfully,

_____

Mr. Moshe Moses Phoshoko

CONSENT FORM (TEACHER)

I, _____, (please print full name) hereby agree to be a participant of the research to be undertaken by Mr. Moshe Moses Phoshoko. I understand that the purpose of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners.

I acknowledge that

- the aims, methods, anticipated benefits and consequences of the research, have been explained to me.
- I voluntarily and freely give my consent to my participation in such research study.
- I understand that results will be used for research purposes and may be reported in teacher and academic journals.
- I am free to withdraw my consent at any time during the study.

I also give consent to: (Please tick the appropriate column)

	Yes	**No**
The voice-recording of the lesson on the concept of variable in which my child/ward might appear as part of the videotext.		
The use and/or production of copies of my notes or any my materials of the lesson on the concept of variable.		

Signature: _____ Date: ___/_____/_06_

Appendix 7: Letter of approval from the GDE to conduct the research

29-08-'06 13:16 FROM- T-411 P02/03 U-894

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Date:	**07 August 2006**
Name of Researcher:	**Phoshoko Moshe Moses**
Address of Researcher:	**754 Eastbank Avenue**
	Alexandra
	2090
Telephone Number:	**0824086926/(011) 8826327**
Fax Number:	**N/A**
Research Topic:	**An exploration of grade 7 teachers' selection of contents in the learning support material in order to promote the understanding of concept of variable amongst the learners**
Number and type of schools:	**2 primary Schools**
District/s/HO	**Johannesburg East**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. ***The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.***
2. ***The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.***
3. ***A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.***

Office of the Senior Manager – Strategic Policy Research & Development
Room 525, 111 Commissioner Street, Johannesburg, 2001 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0488 Fax: (011) 355-0286

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Senior Manager (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher must supply the Senior Manager: Strategic Policy Development, Management & Research Coordination with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Senior Manager concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

ALBERT CHANEE
ACTING DIVISIONAL MANAGER: OFSTED

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	30/08/2006

Appendix 8: Letter of approval from Wits University to conduct the research

Faculty of Humanities: Education Campus

Room 208/9, Administration Block, 27 St. Andrews Road, Parktown • Tel: +27 11 717-3021/18 • Fax: +27 11 717-3219
E-mail: senamelam@hse.wits.ac.za / moshabesham@hse.wits.ac.za

Mr MM Phoshoko
PO Box 234
Alexandra
2014

STUDENT NUMBER 9408991M
Protocol 2006ECE11

03 November 2006

Dear Mr Phoshoko

Application for Ethics Clearance: Master of Education

I have pleasure in advising you that the Ethics Committee in Education of the Faculty of Humanities, acting on behalf of Senate has agreed to approve your application for ethics clearance submitted for the degree of Master of Education for your proposal entitled: **An exploration of grade 7 teachers' selection of contexts in the learning support materials used in order to promote understanding of the concept of variable among learners.**

The Committee has agreed that you may proceed with your research project. However, you need to take note of the following issues:

- You have indicated that subject names will be in the raw data but pseudonyms to be used in the reporting of the results. The Committee has recommended that you use pseudonyms rather than subject names when reporting on the findings of the research conducted;
- Due to the size of the sample (two teachers) anonymity cannot be completely maintained.

Ethical clearance to carry out the research has been granted subject to the above issues being noted.

Yours sincerely

Mathoto Senamela
Senior Faculty Officer for Faculty Registrar
Faculty of Humanities
cc GSEC file
Ethics File
Supervisor: Dr W Mwakapenda
HDethics clearance

Appendix 9: Teacher response to the questionnaire

Questionnaire

Dear Teacher

You are requested to complete the following questionnaire which is part of a research that is seeking to obtain information on what teachers regard as necessary and appropriate for the teaching and learning of the concept of variable. The questionnaire does not seek to determine your proficiency in teaching but your inputs with regard to what you consider as important for this topic are much valued and will be used to inform good practice.

Thank you very much in anticipation of your participation

M. M. Phoshoko (Researcher)

1. Rate the following items in terms of appropriateness for the teaching of the concept of variable? Please cross in the appropriate column for your answer by using the following scale:
   1. most appropriate
   2. more appropriate
   3. appropriate
   4. less appropriate
   5. least appropriate

Items					
interest rates	1	2	**3**	4	5
age	1	2	**3**	4	5
speed	1	2	3	4	**5**
time	1	2	3	**4**	5
shape	1	2	**3**	4	5
set	1	2	**3**	4	5
location	1	**2**	3	4	5
length	1	2	3	4	**5**
angle	1	2	3	4	**5**
money	**1**	2	3	4	5
weather	1	2	3	4	**5**

What other items, not listed here, would you regard as most appropriate for use in the teaching of the understanding of the concept of variable for your learners.

FRACTIONS

2. The following question was given to learners to solve:

> In Mr. Radebe's spaza shop there are 14 loaves of brown bread and 21 cans of fish. If he sells 12 loaves of brown bread at R4.00 each and 7 cans of fish at R3.00 each, how much money did he make from the sale of the two items?

Would you regard this question appropriate for your learners to solve?

Yes [✓] No [ ]

Would this question allow the teacher to check if learners understand the concept of variable?

Yes [✓] No [ ]

Give reason(s) for your answer?

Reason(s)

As GRADE 7 LEARNER you are ABLE To do THIS SUM, THE EDUCATOR HAS To CHECK IF all LEARNERS understands, THere will be LEARNER who do not understand this Question.

3. The following is the response of a learner who was asked to identify the following as either constant or variable.

Zandile Nkosi	constant
rectangle	variable
odd number	variable
13	constant
learners in the class	variable
15 year olds	variable
15 years	constant
15 years old	constant

Would you regard this question appropriate for your learners to solve? Please provide a reason for your answer.

Yes [ ] No [✗]

Reason

Most LEARNERS FIRST have to find out what that terms mean before they can answer it,

CONSENT FORM (TEACHER)

I, [redacted], (please print full name) hereby agree to be a participant of the research to be undertaken by Mr. Moshe Moses Phoshoko. I understand that the purpose of the research is to explore how Grade 7 teachers select and use contexts in the learning support materials in order to promote understanding of the concept of variable among learners.

I acknowledge that

- the aims, methods, anticipated benefits and consequences of the research, have been explained to me.
- I voluntarily and freely give my consent to my participation in such research study.
- I understand that results will be used for research purposes and may be reported in teacher and academic journals.
- I am free to withdraw my consent at any time during the study.

I also give consent to: (Please tick the appropriate column)

	Yes	No
The voice-recording of the lesson on the concept of variable in which my child/ward might appear as part of the videotext.	✓	
The use and/or production of copies of my notes or any my materials of the lesson on the concept of variable.	✓	

Signature: [redacted] Date: 12/09/06

Appendix 10: Transcript of the interview

R: My first question to you would be, what do you understand by the term variable?

T: Honestly I don't understand that term. I don't understand it. What does it mean? What does it entail? But I heard it before but I don't understand it.

R: Did you have to teach it in your… this year, some time this year?

T: No. It depends on what is it? I don't have a clue as I said the other day: what is this guy talking about, I don't have a clue.

R: You don't have clue?

R: Would you recognise numbers that eh… in mathematics where they use letters *x, y* …?

T: (interrupting) Yeah, yeah, yeah, I would recognise that, yeah.

R: Yes. What, what do you call those letters?

T: Eh…

R: Are they just numbers as well? Or….?

T: Letters? And numbers? I think that must be letters.

R: How do you think they are related to….

T: (inaudible)

R: Because in mathematics you get numbers where they say to you, "*x* plus one is seven", you have got to find out what *x* is …

T: (interrupting) …the value of *x*…yeah.

R: …To find the value of *x* and all that … Because I noticed that in your…. in the RNCS they want you to teach the variables, that is why I wanted to find out how you go about in teaching the variable

T: Specifically now the *x*'s

R: Yes. Basically the *x*'s, *y*'s….

T: You know I have been working only this year only with the *x*'s not so with the *y*. How to work with the *x*'s but I was telling my kids that next year they will learn more of the alphabetic words when they go to high school, more of the letters *a, b, c* and upwards. But this year I have been working on the value of *x*. How to work out *x*, I have been working on that. 30

R: Ok, alright. Did you have eh … How did you introduce that part of the work?

T: I can't remember now. But I remember working the value of *x*. How to work out the value of *x*. I can't remember now. But I did that at the beginning of the year, second term. I remember I did that work at the end of the second term. Because in the first term I was doing basic revision, a little bit revision of some Grade 6 work. Second term.

R: So you have no recollection of how you taught it but my question would be how would you – I don't know how to put this – how would you relate that *x* to other numbers in maths. Is there a connection?

T: Yeah, there is a connection. If I can... – I don't know how to say *x* – if I can make maybe a typical example: if you go to shop, maybe there is a certain amount of product which is *x*-amount, so you have to work out what how much that product is, it can take back to what that product is costing in the shop.

R: Now in your own, your personal view about this, what do you think the learners feel about these letters in mathematics, your own experience, as you say you have worked with them. How do they take those letters….

T: (interrupting) Why they have to do it and all that?

R: Yeah. Did they feel they were doing something different?

T: Yes. Definitely. They thought they have been doing something different. Because I mean if you come to Grade 6 I don't think you have worked with *x*'s, it's more in Grade 7 because you are preparing to go to high school. Because in high school it's normal to use those *x*'s and *y*'s and all those stuff. I think it was a change for them to work with *x*, to see what is the value of *x*. I think it was a good experience for them to work out what is the value of *x*.

R: Ok. Maybe let's go a bit away from the *x*, but we will probably come back. The RNCS also requires that whatever that you teach, you should use contexts, that is whatever that surrounds the learners, their everyday experience. How do you feel about that kind of approach in terms of mathematics?

T: Like I said it normally there, what I do normally, you are right when you say that RNCS requires the use of everyday experiences or whatever. Because when I explain something I always make an example, like I said, with a shop. When you go to shop with your mother and you buy loaves of bread, you need to know. I mean if you buy seven you don't have to count: one loaf of bread is seven rand and you have to say 7 + 7 + 7… You have to go, listen: seven loaves of bread, 7 × 7 is 49. So I always make that real life situation: "when you go to shop" and "in real life this is how I am supposed to do it". So real plays a very important role in maths. And that's what I always use, yeah. When I make, but it's not always, but most of the time, I'm trying to include the real life situation in maths and expect them to do multiplication, especially multiplication.

R: What do you, in terms of – I am getting back to the variables now – in real life situations, what is it that maybe you could get in introducing the concept like the *x*'s and *y*'s. What do you think of something that could be used in the real life situation? Do you think of any?

T: Explain that again…

R: What I … As you say that these contexts are very important, my question is that in terms of variables, in terms of *x* and *y*'s, what do think would be things that you would use in real life to introduce these *x*'s and *y*'s in your maths?

T: Make it a little bit clear, I don't understand the question. Make it a little bit simple.

R: To make it a little bit simple, for instance, say for example you, you have… let me get back to your example of *x*-amounts of bread, if you are buying so many *x*-amounts of bread, what price do you pay….

T: (interrupting) … Of one loaf of bread?

R: Yeah, or whatever thing that you can choose. What is it that you choose to use? Do you choose to use the bread or something else?

T: I think I would choose class situations. Because we have many learners who can use class situations. That would be especially nice because here in the class we use the situation in the class. Or situation where they have money, they have money with them inside the class, or make examples of them in the class. Actually that is better that you use examples which are in class, we have examples with us. What's the use here that you talk about something that is far from them. Because now they have to imagine it. It's like to use their imagination.

R: Ok, alright. A very interesting answer. Maybe let us use this time to get back to your responses there. (*Researcher points to the teacher's responses in the questionnaire*.) I note that where you are communicating…. , maybe you are to find that you want to change some of the things you said there, maybe you didn't understand the variable but now…. Would you want to change some other things there?

T: Just explain to me the first one there. They said…. (*Researcher hands the questionnaire responses to the teacher*) I don't think that I would like to change.

R: Ok. Now you indicated that money would be the least appropriate item to use in order to teach the concept of variable. Why did you say that?

T: I think money… you know from the example as I said, I can teach them all these things, by the end of the day, when you have money in your hand, we all know how to use money. But once I have to teach them *x* and *y*, that's going to be difficult. If I tell the child that listen: if I have a thousand rands, count for me that five hundred there, it is easy to count that five hundred. But if I tell the child, listen, go to do *x* plus nine minus that, that's going to be difficult for that child to do that. I don't use money, yeah. I don't use money at all.

R: Ok. And in terms of fractions, you said there's one thing that I left out there that could be used in terms teaching the concept of variable. In what way did you see them as most appropriate?

T: Fractions… we have problems here with learning it. Our school has a problem with fractions. I don't know how learners… I don't know where this does start but our learners have got a problem with fractions. So, most of the time, I try to make real life situations in the classroom when I teach fractions. I try to cut something in half… or take four learners and make an example, 'if you buy a pizza', I say listen, I got a full pizza and I got four boys, and I said how much each one is going to get? And the one said no I will get two slices. And I said no guys, each of you guys is going to get a quarter because a quarter plus a quarter is a half. Because if you are four…. And I said these guys can't, they don't know. And this is basics because you do these things everyday but when you have to come to class and write it, and say a quarter plus a quarter, you say no, a quarter and a quarter gives you one. But I said: "but guys you do these things practically, now you don't understand it!"

R: Very, very interesting because I find that when learners do sometimes solve problems, they forget about what is practical and try to….

T: (interrupting) And they do these things practically, but when it comes to….

R: But they try to do it in a… using what we can call algorithms. They like to look at… remember what is it that you said they must do when they've got numbers that are like that. They never try to do, think or do it as practically as they should, you know.

(pause)

Maybe if we can go to the next page. I have had this question where in question 2 there…(researcher pointing at question 2) where we were indicating about Mr. Radebe….

T: Which one is that?

R: This on (researcher pointing at question 2 again)

T: Oh. This one (teacher pointing at question 2)

R: Yes. Mr. Radebe. "In Mr. Radebe's spaza shop there are 14 loaves of brown bread and 21 cans of fish. If he sells 12 loaves of brown bread at R4.00 each and 7 cans of fish at R3.00 each, how much money did he make from the sale of the two items?" And I asked you those questions and you said that those will be appropriate. Now if that…

(intercom interruption)

Now we are left with about three questions. What would you pick out in this question that will make learners to understand the concept of variable?

T: I think that the question is quite easy. It's not a difficult question. A Grade 7 learner is able to understand a question like that. It's quite easy.

Many use things that are of everyday's life is brown bread and fish. They will understand a question like that.

R: They will understand it? So would you pick out everything to teach that concept of variable?

T: Yes. Everything.

R: What would be the variables that you would pick out from there?

T: Ah. They use numbers.

R: They what?

T: They use numbers there. Like I said, it's quite easy, I mean….

R:(interrupting) My question is: Would you say the loaves are the variables, or the cans are the variables or the money is the variable…?

T: (interrupting) I think the money is the variable. Because at the end of the day they have to work out how much money…

R: Would you say the loaves are the variables? (Teacher shakes head) No?

T: No. I don't agree the loaves are the variables.

R: Why would you say they are not variables then?

T: Because at the end of the day we want the question of money. They want to know how much money was used here.

R: And in what way was the money the variable?

(interruption)

T: Because we work with numbers and with figures. At the end of the day we want figures.

R: Ok. Alright. The last question would be: here in question 3 you were asked whether this kind of a question if you have given to learners to do, would you regard the question as appropriate. And you indicated that…

T: (interrupting) That the learners have to find out what the terms mean before they can answer it.

R: Yeah. My question is which of…. Is it the terms this side or the terms that side?

T: The terms that side. (pointing the right-hand column of the question)

R: Oh. You mean the terms that side.

T: There is no use if you teach a child something they don't understand. If you understand the terms and what it means then it's much easier.

R: Do you have any understanding of the two terms?

T: No. The variable, yeah. (inaudible) constant, I don't know. I don't know what you mean by constant.

Date:

Assessment Activity 3.6

Work in pairs

1 Write the word sentences below as number sentences:
- **a** The sum of p and q is 7.
- **b** The product of a and b is 15.
- **c** The difference between x and y is 6.
- **d** The quotient when z is divided by m is 3.

2 Copy and complete the table below that shows that $a + b = 6$.

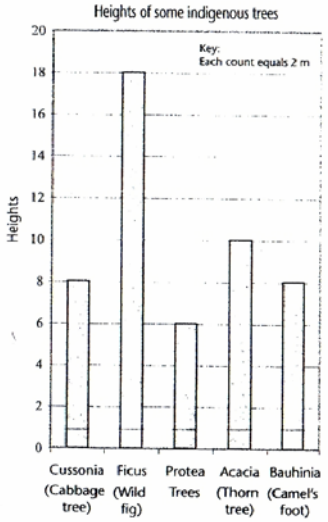
If a =	0	1	2	3	4	5	6
b =	6						

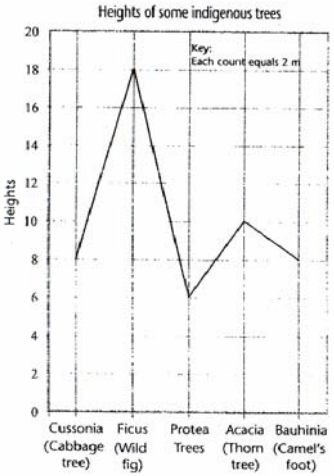
3 If x equals a whole number:
- **a** What is the whole number after x?
- **b** What is half of x?
- **c** What is twice x?
- **d** What is the whole number before x?

4 True of false?
- **a** If $x = 3$ then $x + 7 = 9$. Check by substituting x with 3.
- **b** If $y = 23$ then $y - 12 > 7$. Check by substitution.
- **c** If $z = 8$ then $7z < 20$. Check by substitution.
- **d** If $a = 7$ then $\frac{21}{a} = 3$. Check by substitution.

5 Solve the following number sentences by finding the values of the place holders and check the answers by substitution:
- **a** $5 \times b + 9 = 49$
- **b** $4 \times c - 5 = 7$
- **c** $11 + d - 7 = 10$
- **d** $(e + 3) \times 2 = 8$
- **e** $(5 + f) \div 2 = 4$
- **f** $6 \times 5 + g = 4 \times 9$
- **g** $(9 \times h) \div 12 = 2 \times 3$
- **h** $7j + 12 = 6(9)$.

6 Some well-known indigenous trees are Cussonia, Ficus, Protea, Acacia and Bauhinia. Discuss the bar graph on the next page.
- **a** What does the graph show us?
- **b** How many trees are shown?
- **c** Name the trees shown.
- **d** What do the numbers on the vertical axis tell us?
- **e** How tall are the trees altogether?
- **f** Which tree is the shortest?
- **g** Which tree is the tallest?
- **h** What is the difference between the shortest and the tallest trees? Write a number sentence to show this.





Controlled By:
[redacted]
HOD: Senior work

Assess your partner!	**Yes** 4	**Quite well** 3	**Not very well** 2	**Needs help** 1
Can _____ write word sentences as number sentences?				
Can _____ find the value of place holders in number sentences?				
Can _____ read number sentences from graphs?				

Date:

Assessment Activity 3.7

Work alone

1 In which of these numbers does the 6 mean $\frac{6}{10}$:
a 6,27 **b** 62,7 **c** 627?

2 Write the numbers represented by these addition sums in decimal form:
a $4 + \frac{8}{10} + \frac{6}{100} + \frac{2}{1\,000}$
b $36 + \frac{7}{10}$
c $7 + \frac{4}{10} + \frac{3}{100} + \frac{2}{1\,000}$
d $23 + \frac{15}{1000}$.

3 Convert the following decimal fractions to common fractions:
a 0,1 **b** 0,2 **c** 0,3
d 0,25 **e** 0,75 **f** 0,025
g 0,001 **h** 0,125 **i** 0,88.

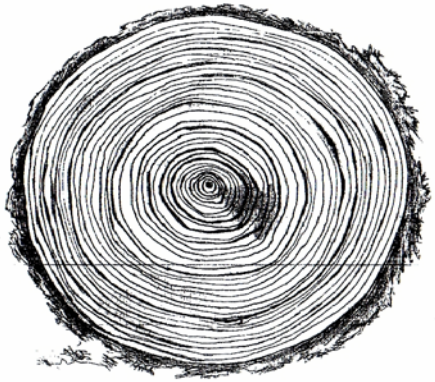
4 Complete:
a 200 g = ____ kg **b** 4 kg 20 g = ____ g
c 4 156 g = ____ kg **d** 10 kg 456 g = ____ g
e 300 g = ____ kg **f** 7,234 kg = ____ g.



5 A gardener plants seedlings for an hour. He spends $\frac{5}{12}$ of the time digging the holes and then plants four rows of seedlings.
a How many minutes does he spend digging?
b Convert this to seconds.
c How long does he take to plant one row if he rests for a total of 10 minutes between rows?
d Convert this time to seconds.

6 **a** How many minutes are there in $4\frac{3}{4}$ hours?
b How many seconds is this?

7 Convert:
a 7 hours to minutes **b** 900 minutes to hours
c 96 hours to days **d** 98 days to weeks
e $\frac{1}{6}$ hours to minutes **f** $7\frac{2}{5}$ hours to minutes.



8 A tree was exactly 34 years old in the fourth month in 1990. When was it planted? Give the month and year.

Controlled By:
[redacted]
HOD: Senior work

Assess yourself!	Yes 4	Quite well 3	Not very well 2	I need help 1
Can I convert fractions to decimals?				
Can I convert decimals to fractions?				
Can I work with mass and time?				

Date :

Assessment Activity 4.1

Work alone

1 a What is a short way to write 10 to the power of 5?
b What is a long way to write 10^3? Give the product.
c What is a long way to write 2^5? Give the product.

2 a What is a short way to write $10 \times 10 \times 10 \times 10 \times 10$?
b What is the product of $10 \times 10 \times 10 \times 10 \times 10$?
c What is a short way to write $3 \times 3 \times 3 \times 3$?
d What is the product of $3 \times 3 \times 3 \times 3$?

3 What do the following equal:
a 6^3 b 3^4 c 7^3?

4 Calculate:
a $3^2 + (8^2 - 2^3) \times 4^3$
b $10^6 - (10^2 + 10^3) \div 10^2$.

5 Write down the answers only:
a $4^2 + 5^2$
b $6^2 - 3^3$
c $8^2 \div 4^2$
d $3^2 \times 5^2$
e $10^2 + 10^3 + 10^5 + 10^6$
f $2^2 + 2^2 + 2^2 + 2^2 = 4 \times ___ = ___$.

6 Calculate the following, then where necessary, rearrange the numbers so that addition is done first and check your answers:
a 123 + 234
b 2 547 + 4 589
c 3 567 + 4 432 + 2 569
d 29,27 + 0,76
e 233 + 432 − 234 + 531 − 132
f 935 − 97 + 321 − 387.

7 Calculate and compare the answers:
a 7×8 and 8×7
b 12×13 and 13×12.

8 Calculate the following, then rearrange the order of the numbers and check your answers:
a 48,29 + 27,05 − 19,99 − 9,77 + 35,29
b $36{,}72 \div 3 \times 3 \div 10$
c 234,8 − 167,79 + 345,62 − 243,9.

9 Calculate the following by first bracketing together the subtrahends:
a 89 − 12 − 17 − 32 − 24 b 479,7 − 55,3 − 64,7 − 96,7.

10 Calculate the following by first bracketing together the divisors:
a 900 g ÷ 9 ÷ 10 b 15 000 m ÷ 5 ÷ 3.

11 Find the common multipliers in the following and then calculate:
a $7 \times 7 + 7 \times 3 + 7 \times 6$
b $31 \times 23 + 31 \times 32 + 31 \times 40$
c $589 \times 211 + 589 \times 342 + 589 \times 526$.

12 Complete by rounding off the first numbers to the nearest 10:
a $27 + 7 = (27 + \square) + (7 - \square) = \square + \square = ___$
b $69 + 7 = (69 + \square) + (7 - \square) = \square + \square = ___$
c $355 + 128 = (355 + \square) + (128 - \square) = \square + \square = ___$
d $989 + 97 = (989 + \square) + (97 - \square) = \square + \square = ___$
e $1\,294 + 396 = (1\,294 + \square) + (396 - \square) = \square + \square = ___$.

Controlled By:
[redacted]
HOD: Senior work

Assess yourself!	Yes 4	Quite well 3	Not very well 2	I need help 1
Can I work with exponents?				
Can I do mental calculations?				
Can I rearrange numbers in calculations?				
Can I group subtrahends before calculating?				
Can I recognise a common multiplier before multiplying?				

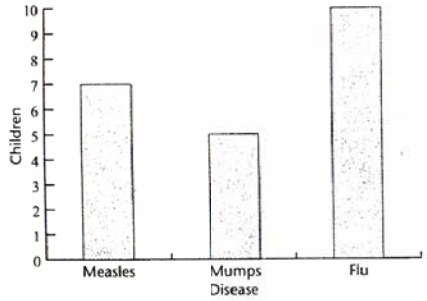
Date:

Assessment Activity 4.2

Work alone

1 Write a data collection sheet to show the number of boys and the number of girls in your class.
- **a** Use the sheet to collect the necessary information.
- **b** Show the information you have collected on a vertical bar graph.
- **c** Write down four questions you could ask about the graph you have made.
- **d** Ask a friend to answer the questions.

2 Look at the graph below.



- **a** How many children have each disease?
- **b** How many children altogether are sick?

3 Complete the following by using related operations to find the variables:
- **a** $5 + 5 + 5 = 3 \times p = q$
- **b** $46 + 46 + 46 + 46 + 46 + 46 = r \times s = t$
- **c** $192 - 24 = 168$; $168 - 24 = 144$; $144 - 24 = a$; $a - 24 = b$; $b - 24 = c$; $c - 24 = d$; $d - 24 = e$; $e - 24 = f \therefore g \div h = i$.

4 Draw flow diagrams to find the equivalent fractions of the following:
- **a** $\frac{3}{5} = \frac{\star}{10} = \frac{\star}{15} = \frac{\star}{20}$
- **b** $\frac{5}{6} = \frac{\star}{12} = \frac{\star}{18} = \frac{\star}{24} = \frac{\star}{48}$
- **c** $\frac{5}{9} = \frac{\star}{27} = \frac{\star}{36} = \frac{\star}{54} = \frac{\star}{72} = \frac{\star}{90}$.

5 Draw flow diagrams to find the following numerators:
- **a** $\frac{16}{20} = \frac{\star}{5}$
- **b** $\frac{28}{42} = \frac{\star}{3}$
- **c** $\frac{24}{36} = \frac{\star}{3}$
- **d** $\frac{39}{52} = \frac{\star}{4}$
- **e** $\frac{27}{45} = \frac{\star}{5}$
- **f** $\frac{55}{77} = \frac{\star}{7}$
- **g** $\frac{32}{56} = \frac{\star}{7}$
- **h** $\frac{670}{700} = \frac{\star}{70}$.

6 Draw flow diagrams to help you complete the following:
- **a** $\frac{250}{1\,000} = \frac{25}{\star} = \frac{\star}{4}$
- **b** $\frac{40}{90} = \frac{\star}{9} = \frac{\star}{18}$
- **c** $\frac{6}{12} = \frac{1}{\star} = \frac{5}{\star}$
- **d** $\frac{72}{80} = \frac{\star}{10} = \frac{18}{\star}$
- **e** $\frac{140}{180} = \frac{7}{\star} = \frac{21}{\star}$
- **f** $\frac{88}{99} = \frac{8}{\star} = \frac{\star}{27}$
- **g** $\frac{28}{35} = \frac{\star}{5} = \frac{\star}{50}$
- **h** $\frac{30}{42} = \frac{5}{\star} = \frac{\star}{140}$
- **i** $\frac{63}{81} = \frac{\star}{9} = \frac{14}{\star}$
- **j** $\frac{48}{60} = \frac{4}{\star} = \frac{8}{\star}$.

Controlled By:
[redacted]
HOD: Senior work

Assess yourself!	Yes 4	Quite well 3	Not very well 2	I need help 1
Can I draw and use a data collection sheet?				
Can I read the information on a bar graph?				
Do I know what equivalent numbers are?				
Do I understand the relationship between addition and multiplication?				
Do I understand the relationship between subtraction and division?				

Date:

Assessment Activity 4.3

Work alone

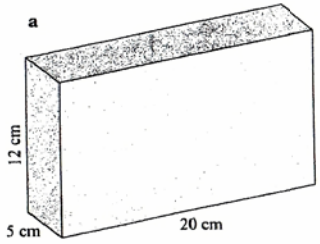
1 Calculate the perimeter of a square with sides:
- **a** 110 cm
- **b** 9 cm
- **c** 4,8 m
- **d** 38 mm.

2 Calculate the perimeter of a rectangle with one side 13 cm and the other:
- **a** 129 cm
- **b** 52 cm
- **c** 0,3 m
- **d** 45 mm.

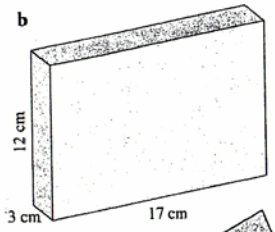
3 Calculate the area and perimeter of the following:
- **a** a square with sides 49 mm
- **b** a rectangle with sides 23 cm and 49,1 cm.

4 Calculate the volumes of the figures below.

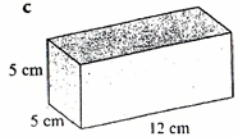
a



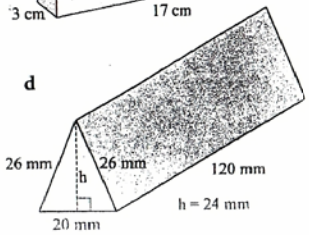
b



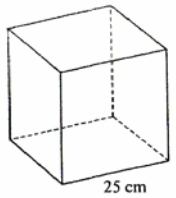
c



d



5 The edge (side) of a cube is 25 cm long.
- **a** Draw a net of the cube.
- **b** Calculate the area of the net.
- **c** If the cube is a container with an inside length of 25 cm, how many litres will it hold?



6 Find the difference in length between:
- **a** 1 cm and 9 mm
- **b** 30 cm and 30 mm
- **c** 22 cm and 25 mm
- **d** 2 m and 2 cm
- **e** 1 m and 35 cm
- **f** 3 m and 75 cm
- **g** 2 cm and 15 mm
- **h** 3 m and 30 cm
- **i** 10 cm and 15 mm
- **j** 3 m and 150 mm
- **k** 2 m and 15 mm
- **l** 3 m and 2 000 mm.

7 A cyclist stopped twice on a journey. What was the total distance he cycled in kilometres, if the three parts of his trip were 3,9 km; 98,6 m and 1 365 m?

8 The string in a ball is 60 m long. If 167 cm is cut from the ball, how much is left in centimetres? And in metres?

Controlled By: [redacted]
HOD: Senior work

Assess yourself!	**Yes 4**	**Quite well 3**	**Not very well 2**	**I need help 1**
Can I calculate the perimeter of squares and rectangles?				
Can I calculate volume?				
Can I calculate length?				