2

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Mathematics, pedagogy and textbooks: a study of textbook use in Grade 7 mathematics classrooms

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by
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Declaration

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature Signed by candidate

Signature Removed

07 September 2001

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Abstract

This dissertation is concerned with a systematic description of the recontextualization of the practices of a textbook, *Maths for all Grade 7 Learner's Activity Book*, when it is incorporated into grade 7 mathematics teachers' classroom practices. In particular, the research described here focuses on the impact of the textbook on four grade 7 mathematics teachers' classroom practices.

My study forms a sub-project of a larger research project which explores the impact of the textbook, *Maths for all Grade 7 Learner's Activity Book*, in 14 grade 7 mathematics classrooms. The research design of my study comprised two aspects: an analysis of a chapter from the textbook, *Maths for all Grade 7 Learner's Activity Book,* and an analysis of its use in classrooms. Data collected included a textbook chapter on measurement and the accompanying chapter in the teacher's guide, questionnaires (learner, teacher and school), teacher interviews, video recordings of observed lessons and learner notebooks.

Drawing largely on Paul Dowling's *Social Activity Theory* and Paula Ensor's extension of this work in her study on teacher education, a theoretical model was developed for the analysis of data. The theoretical model was supplemented with theoretical concepts from Basil Bernstein's sociological theory of pedagogic discourse. While the model was developed in relation to the content and use of a specific textbook, the model can potentially be used for other mathematics textbooks or textbooks from other disciplines.

Analysis shows that the textbook, which embodies an inductive, exploratory pedagogy, cannot on its own achieve learner's apprenticeship into mathematics, or teacher's apprenticeship into its privileged mode of teaching mathematics. The analysis of the teachers' use of textbook shows that in most cases, the privileged pedagogy of the textbook differed considerably from the preferred pedagogy of the teachers. Most teachers preferred a deductive pedagogy and used the textbook in ways which fragmented the mathematical knowledge presented to learners, reduced the mathematical complexity of the textbook tasks and consequently transformed the pedagogic intentions of the textbook. The research therefore concludes that

the transformative role of the textbook needs to be accompanied by teacher development programmes.

Abbreviations

C2005	Curriculum 2005
DET	Department of Education and Training
DOE	Department of Education
FET	Further Education and Training
GET	General Education and Training
INSET	In-service education and training
LAB	Learner's Activity Book
LSM	Learning Support Materials
MEP	Mathematics Education Project
Mfa	*Maths for all*
MLMMS	Mathematical Literacy, Mathematics and Mathematical Sciences
OBE	Outcomes-based-education
ORF	Official Recontextualizing Field
PEI	President's Education Initiative
PRESET	Pre-service Education and Training
PRF	Pedagogic Recontextualizing Field
TRB	Teacher's Resource Book
SDU	Schools Development Unit
SOs	Specific Outcomes
TIMSS	Third International Mathematics and Science Study
UCT	University of Cape Town

List of figures

List of plates

List of tables

Table of Contents

Chapter 1

Conceptualising the study

1.1 Motivation for the study

The motivation for this study was stimulated by a dual impetus. The first impetus arose from my work as a mathematics educator for a Non-Government Educational Organisation, the Mathematics Education Project (MEP)[1] based at the University of Cape Town. My interest in this study was further fuelled by the current curriculum context within South Africa. Firstly, I discuss the current curriculum context and then focus attention on the work of MEP.

1.1.1 Current curriculum context

The South African educational system is currently in the throes of intense upheaval and transformation at all levels of the system. Of particular concern for this study, is the focus on the current curriculum innovation which is underpinned by Outcomes-based-education (OBE). Curriculum 2005 (C2005) was launched in South Africa in 1997 with the explicit intention of transforming South Africa into a democratic, non-racist, non-sexist society and improving the country's economy. C2005 outlines the knowledge, skills and attitudes that learners in the General Education and Training (GET) band are to acquire by the time they exit school. C2005 emphasises learning that is relevant to the everyday world and advocates a learner-centred pedagogy involving collaboration with other learners[2]. The relationship between C2005 and textbooks is discussed below.

In their report on Learning Support Materials (LSMs) in C2005, Czerniewicz et al (2000) comment on the lack of clarity on the role of textbooks in teaching and learning as articulated in C2005 policy documents. They contend that there are conflicting statements about textbooks in policy documents. In some policy documents textbooks are set up as alternatives to learning support materials (LSMs) and are negatively associated with

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[1] MEP and the Teaching and Learning Resource Centre have been incorporated into the Schools Development Unit (SDU) since the beginning of 2000.

[2] Since its launch, C2005 has been implemented in grades 1- 4, 7 and 8, has been reviewed by a ministerial committee (in 2000) and has been through a strengthening and streamlining process. The Revised National Curriculum Statement (July, 2001) defines learning outcomes, within each learning area at each grade level, that clearly articulate the sequence of learning outcomes to be achieved and identifies the assessment standards at each grade level against which learners are meant to be assessed.

'traditional textbook-centred' teaching practices. In other documents, textbooks are viewed as one of a range of resources available to teachers to design their own learning programmes (Czerniewicz, 2000 et al: 16). Adler et al (2001) raise the same concern over the contestation around the role of textbooks in teaching and learning of mathematics.

> An important question is whether the tenets of Curriculum 2005 appropriately problematise textbooks as teaching–learning resources or whether C2005 simply and rhetorically undermines the textbook as a teaching–learning resource. Present in the discourse of C2005 is a notion that prescribed texts are too restrictive for the development of a learner-centred curriculum. [...] Embedded in the discourse about prescriptive textbooks is an assumption that teachers are able to develop their own materials for teaching and learning, ... (Adler et al, 2001: 4)

Their research study concludes that despite the rhetoric within the discourse of C2005 which undermines textbook use, it appears that curriculum reform has in practice stimulated rather than inhibited textbook use amongst learners and teachers. In addition, Adler et al (2001) argue that the textbook continues to be an integral component of teaching and learning mathematics[3]. The reports of Adler et al (2001) and Czerniewicz (2000) together suggest that textbook use is a controversial issue within curriculum reform in South Africa. I now move to discuss MEP's work in relation to materials development.

1.1.2 MEP's work

MEP has been in existence in various forms since 1986 and remains involved in school development, teacher development and materials development at both GET and FET (Further Education and Training) level. MEP's materials development has always been closely linked to its teacher development strategies. Initially MEP produced 'alternative' materials to the traditional textbooks that were part of the educational system. These materials were intended to challenge the socio-political status quo and as such were explicit about intentions to undermine apartheid[4]. These materials which were largely discrete activities for teachers advocated an investigative, learner-centred pedagogy (to be

[3] Significantly, the Draft Revised National Curriculum Statement (2001: 12) explicitly states that 'Learning support materials (including textbooks) and teacher development programmes will play an important role in interpreting and expressing the Learning Outcomes and Assessment Standards'.

[4] The materials focused attention on the Eurocentric nature of traditional school mathematics by attempting to highlight the contribution to mathematics from different parts of the world. This focus can be linked to writers supporting ethnomathematics such as Paulus Gerdes (1988) and D'Ambrosio (1985). In addition, MEP materials sought to highlight racial and gender bias in mathematics as well as explore the political nature of mathematics and the potential of mathematics to empower marginalised people in society – a view influenced and promoted by critical theorists such as Frankenstein (1989) and Skovsmose (1985).

discussed later in this thesis). In particular, these materials were used in MEP's INSET programmes with the intention of transforming teachers' classroom practice from the 'traditional' deductive pedagogy to a learner-centred, inductive pedagogy.

In 1997 MEP embarked on a textbook project to produce learner books for grades 1 to 9 with accompanying teacher guides, the *Maths for all* textbook series[5]. For the first time, the focus of MEP's materials development shifted from the production of discrete teacher materials to developing a systematic learning programme for learners. This materials development venture corresponded with the launch of C2005. These textbooks were to incorporate MEP's philosophy of teaching and learning mathematics, which in many ways corresponds to the learner-centered pedagogy promoted by C2005[6]. The extract from 'To the teacher' in Grade 7 *Maths for all* (*Mfa*) Learner's Activity Book (LAB) highlights the textbook series' support of Curriculum 2005.

> *Maths for all* is a totally new series of learners' activity books and teacher's resource books written for Outcomes Based Education and Curriculum 2005. (Mfa7 LAB: ix)

The *Maths for all* textbook series consequently positions itself within the 'progressive' pedagogy articulated in the curriculum documents.

The textbook project was envisaged by MEP as an opportunity to contribute towards large scale transformation of teaching practices through the production of a coherent, systematic learning programme in mathematics for each grade of the GET phase. The textbook project was seen as supplementary to the teacher development projects of MEP and was intended to reach areas of South Africa that could not easily be reached by the organisation itself or other teacher development organisations.

In a context where large numbers of South African teachers are under-qualified, particularly in mathematics and science, and where the state does not have sufficient funds available to spend on teacher education, the textbook is often seen as a powerful means of influencing teachers' classroom practice. The importance of textbooks and other learning

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[5] My role in the textbook series was mainly as an internal consultant to the Senior Phase books.

[6] The production of this textbook series, *Maths for all* (*Mfa*) signalled a shift from an antagonistic relationship with the state prior to 1994 to a collaborative relationship. This relationship between the

materials in the learning process is well documented in the literature on international research on learning materials[7].

> According to Crouch and Mabogoane (1997), this [international – SJ] literature suggests that some of the most important predictors or precursors of cognitive development as opposed to access to schooling is the access of learners to learning materials such as books and stationery. (Taylor & Vinjevold, 1999: 166)

and

> The Third International Mathematics and Science Study (TIMSS), which compared the mathematics and science performance of pupils in 41 countries, has shown how decisive are the effects of textbooks on pupil learning. (Taylor & Vinjevold, 1999: 166-167)

My interest in this study was sparked by a desire to investigate how a textbook which embodies a 'new' pedagogy and based on a 'new' curriculum would be used by teachers who had not received any training on how to use the textbook[8]. In particular, my interest in textbook research was extended by the alternative form of the *Maths for all* textbook series, which differed from the traditional textual format of exposition-worked example–exercise. The form of the *Mfa* textbook will be described in more detail in Chapter 4.

My research interest dovetailed with a research project on *Maths for all* Grade 7 Learner's Activity Book (LAB) initiated by a mathematics educator in the Department of Education at UCT in conjunction with MEP. My study thus forms a sub-project of the main research project which is described below.

1.2 Main research project

The main research project was set up to analyse the impact of *Mfa7* LAB's content and pedagogy on Grade 7 mathematics teaching and learning in urban ex-DET schools. Its objective is to investigate relationships between textbook practices and teachers' use of the textbook for teaching and learners' achievement. An assumption underpinning this research is that skillfully designed textbooks properly used can complement the new curriculum and assist teachers in improving teaching and learning of mathematics.

The research question for the main research project is:

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organisation and the state can be described through Bernstein's (1990) sociological theory which is outlined in section 1.3 of this chapter.

[7] See section 1.4 for a detailed literature review on textbooks.

[8] The reality in South Africa is that teachers usually use textbooks without support and training.

Is the content and pedagogy of the Maths for all Grade 7 LAB and associated teacher's guide developed to support Grade 7 teachers in the implementation of Curriculum 2005, effective in former DET urban schools in terms of teachers' teaching and learners' acquisition of mathematics knowledge?

The intentions of the main research project are to:

- identify and make explicit the textbook content and pedagogy developed to support C2005.
- develop a research model which can be used to evaluate textbook practices through
  - teachers' use of textbooks for teaching; and
  - levels of learner achievement.
- analyse the impact of the textbook content and pedagogy on Grade 7 mathematics teaching and learning.

The research design of the main research project is elaborated in Chapter 3. In the next section, I discuss the particular focus of my research study.

1.3 Research focus of my study

My study focuses on two aspects of the main research project: the analysis of a chapter from the *Mfa7* LAB and teachers' use of this in their classrooms. The research question of my study can be stated as follows:

What is the impact of Mfa7 LAB on Grade 7 mathematics teachers' classroom practice?
This question generates two sub-questions as follows:

- What is the nature of the pedagogy privileged in *Mfa7* LAB and associated Teacher's Resource Book (TRB)?
- How do teachers in Grade 7 mathematics classrooms use this textbook?

Both local and international research (Langhan, 1993; Taylor & Vinjevold, 1999 and Apple and Christian-Smith, 1991) points to the transformation of textbooks when used by teachers in classrooms.

> There is considerable evidence to show that teachers mediate materials and adapt them to existing practice, especially when there is no accompanying teacher development. Even critical theorists, who emphasise the power of LSMs, point to the ways in which teachers subvert textbooks: 'We cannot assume that what is 'in' the actual text is actually taught. Nor can we assume that what is taught is actually learnt. Teachers have a long history of mediating and transforming that material when they employ it in their classrooms.' (Apple and Christian-Smith, 1991: 14, cited in Czerniewicz et al, 2000: 43)

In this study, the transformation referred to by Apple & Christian-Smith (1991) is understood as a form of *recontexualization*. Both Dowling (1998) and Bernstein (1996) assert that when a discourse moves from one site to another, this discourse is recontextualized. As such, transformation of the contents of a discourse across contexts occurs.

Dowling and Bernstein's notions of recontextualization are similar even though they are located within two different theoretical frameworks. Dowling's concept of recontextualization is located within his language of description, *Social Activity Theory*, and Bernstein's concept of recontextualization is defined within his theory of the pedagogic discourse. Dowling defines recontextualization as follows:

> [...] insofar as an activity can be empirically described as exhibiting a particular structure of social relations, then this structure will tend to subordinate to its own principles any practice that is recruited from another activity. I want to refer to this position as the principle of recontextualization. (Dowling, 1998: 24)

and

> I shall use the term *gaze* to refer to a mechanism which delocates and relocates, that is, which *recontextualizes* ideological expression and content. The result of such recontextualizing is to subordinate the recontextualized ideology to the regulating principles of the recontextualizing ideology and its subjects as virtual subjects, which is to say as objects. (Dowling, 1998: 136 – italics in original)

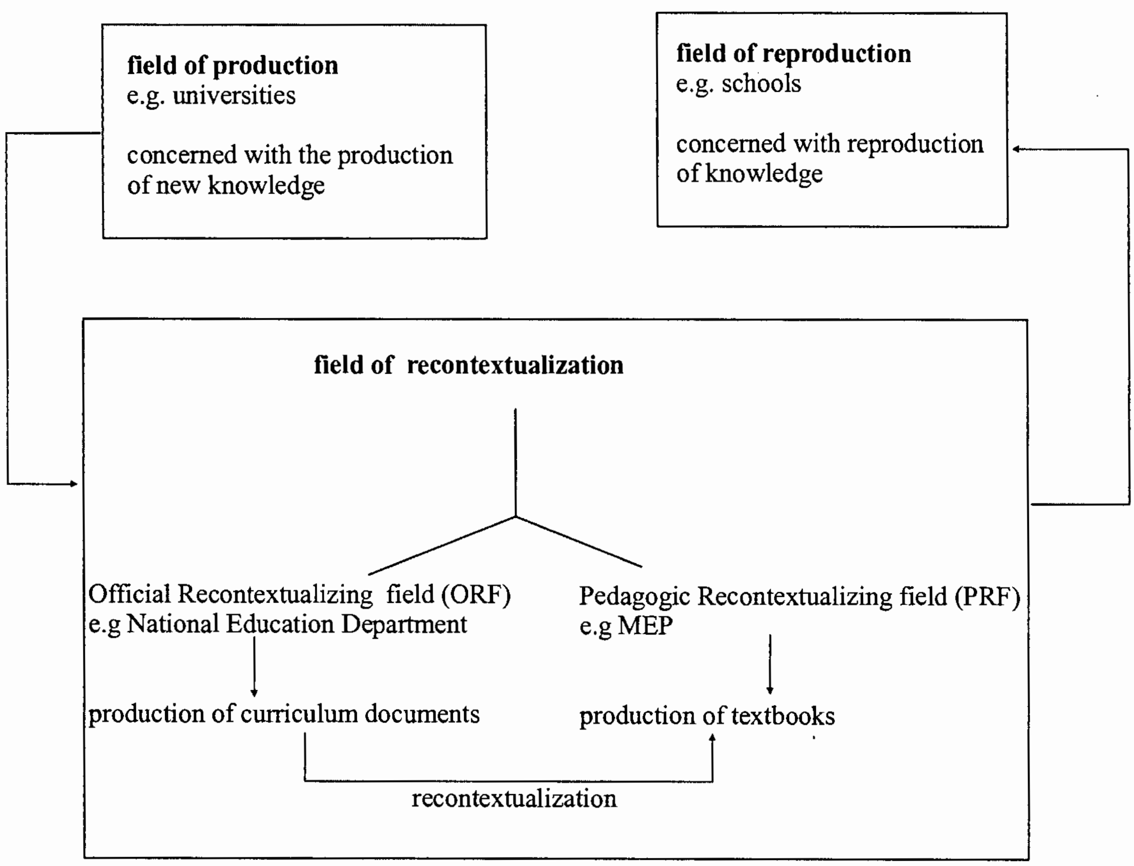
School mathematics is an example of what Bernstein refers to as pedagogic discourse. School mathematics is constituted from elements of academic mathematics together with selections from the field of politics, developmental psychology and theories of learning. Pedagogic discourse sets out the contents and the method of transmission and acquisition of this knowledge. At the level of the classroom, textbooks are pedagogic texts[9] which embody pedagogic discourse and realise the recontextualizing principles of the curriculum.

[9] Bernstein defines a text as anything that attracts evaluation (Bernstein, 1996: 32). See Chapter 2 for a more detailed discussion of pedagogic texts.

A textbook has narrative features and elements of progression which make it different from discrete classroom materials. A textbook therefore constitutes an interpreted curriculum for teachers. How this interpreted curriculum is implemented depends on many factors: the teacher's mathematical knowledge, the context of the school, the teacher's own background in education etc. The implemented curriculum potentially differs from teacher to teacher.

Bernstein's (1990) notion of fields within educational systems provides a framework for examining the relationship between a curriculum and textbooks. He identifies three fields namely, fields of production of discourse (primary context), fields of reproduction of discourse (secondary contexts) and fields of recontexualizing.

Figure 1.1 Bernstein's model of pedagogic discourse



Adapted from Bernstein (1990)

The *field of production* comprises institutions involved in educational research and teaching. The primary focus of these involve processes where 'new ideas are selectively created, modified, and changed and where specialized discourses are developed, modified, or changed' (Bernstein, 1990: 191). In other words, it is in this field that 'new' knowledge is created. It is within the field of production that vertical discourse[10], in this case mathematics, is produced. The *field of reproduction*, located in schools and colleges, is concerned with the selective reproduction of educational discourse.

Bernstein contends that the *field of recontextualization* links the *field of production* with the *field of reproduction* by 'creating, maintaining, changing and legitimizing discourse, transmission, and organizational practices which regulate the internal orderings of pedagogic discourse' (Bernstein, 1990: 193). Educational discourse produced in the *field of production* (academic field) is transformed in the recontextualizing field to constitute a 'new' discourse that is reproduced in the *field of reproduction*. However, Bernstein maintains that the educational discourse, reproduced in schools, may be transformed by the specific context of a school and the primary cultural context of the learner. Thus educational discourse transformed in the recontexualizing field may undergo further recontextualization when inserted into local pedagogic practices within specific schools.

Bernstein (1990) identifies two sub-fields within the *recontextualizing field*: ORF (Official Recontextualizing Field) and PRF (Pedagogic Recontextualizing Field). The ORF, located within specialised State departments such as National and Provincial educational departments in South Africa, regulates the official pedagogic discourse through, for example, constructing official curriculum documents and educational policy. The ORF regulates official pedagogic discourse which expresses the dominant principles in society and regulates the activities of the PRF and pedagogic discourse of reproduction. Non-government INSET organisations, textbook publishing houses, professional teacher associations and other non-governmental educational institutions constitute the PRF. In the past, the relationship between the ORF and PRF in South Africa was characterised as antagonistic. The cooperative relationship between the ORF and PRF, in South Africa in the 1990s could be attributed to a common goal of transforming education for all sectors of South African society. C2005 was produced within the ORF with large support from the PRF. In particular the *Mfa* series of textbooks, produced within the PRF, affiliates with and

[10] Bernstein (1996) distinguishes between vertical discourse (academic knowledge) and horizontal discourse (everyday knowledge).

supports C2005 and can be considered as a recontexualization of C2005. This is discussed in Chapter 4.

There are therefore two levels of recontextualization involved in this study. The first level concerns the recontexualization of C2005 within the *Mfa* series, while the second level involves the recontexualization of the *Mfa7* textbook within teachers' classroom practice. The first level of recontextualization forms a backdrop upon which the study rests but does not form its central focus. The task of this study is to develop a theoretical model that enables a systematic description of the recontextualization of a textbook when it is incorporated into a teacher's classroom practice. This study, and the main research project with which it is associated, seeks to address the gaps in research on textbooks in South Africa as identified by Taylor & Vinjevold (1999), Czerniewicz et al (2000) and Adler et al (2001). Taylor & Vinjevold (1999) report that there is a lack of 'large scale studies of the effects of textbooks or other learning materials on pupil learning in South Africa' (Taylor & Vinjevold, 1999: 167). Furthermore Czerniewicz et al (2000) claim that classroom-based research in South Africa has 'mostly been qualitative and perhaps less than rigorous (e.g. Threshold Project 1990; PEI research 1999; various C2005 evaluations 1998-1999)' (Czerniewicz et al, 2000: 36).

In this section, I have outlined the research focus of my study and its relationship to the main research study. In the next section, I extend the discussion on the research question of my study.

1.4 Sharpening the research question

As discussed above, the focus of this study is the recontextualization of a particular textbook, *Mfa7* LAB as used by Grade 7 mathematics teachers in classrooms. As such the research question: '*What is the impact of Mfa7 LAB's on Grade 7 mathematics teachers' classroom practice?*' produces two key aspects of research design and analysis:

1) an analysis of the textbook and
2) an analysis of how the textbook is used by teachers.

These two aspects of my research are elaborated below.

1.4.1 Analysis of the textbook

The analysis of the textbook, *Mfa7* LAB is intended to describe the nature of the mathematics made available to learners and the privileged mode of teaching mathematics made available to teachers. It describes the expected conduct of teachers and learners and the relationship between them that it privileges. The following sub-questions that generate the analysis are outlined below:

- What mode of teaching and learning mathematics does *Mfa7* LAB privilege?
- How does the textbook construct learners, teachers and mathematics?
- How does the textbook make mathematical knowledge, in particular of the topic of measurement, available to learners and teachers? In other words, to what extent are teachers and learners given access to the recognition and realization rules[11] for the topic of measurement?
- To what extent does the textbook make the privileged pedagogy (the identities of learners and teachers, the relationship between them and privileged mode of learning and teaching mathematics) available to teachers and learners? In other words, to what extent are teachers and learners given access to the recognition and realization rules of the privileged pedagogy?

The presentation of the analysis developed in Chapter 4 attempts to address the questions set out above and constitutes the first part of the study. The second part of the study, which focuses on the teacher's use of textbooks in classrooms, is discussed below.

1.4.2 Analysis of how teachers use the textbook

The analysis of the textbook enables me to examine in a fine-grained manner the nature of the recontextualization of the textbook when incorporated into a teacher's classroom practice. This part of the study analyses teachers' use of a textbook in their classrooms. The sub-questions, which this part of the study seeks to address, are outlined below:

- What is the nature of the teacher's classroom practice?
- How do teachers, through their classroom practice, construct learners and mathematics?

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[11] Bernstein's (1996) notion of recognition and realization rules will be discussed in Chapter 2.

- How does the teacher's preferred teaching mode compare with mode of teaching privileged in the textbook?
- How does the teacher's pedagogy compare with the pedagogy privileged in the textbook?
- How do teachers use *Mfa* in their classrooms? How do teachers use *Mfa* to design their lessons? How do teachers use *Mfa* with their learners?
- How do the practices privileged in the textbook become transformed (recontextualized) when incorporated into a teacher's classroom practice?

In the discussion above, I have outlined the motivation for my study, located it within a larger research study, and described the research focus and research question and sub-questions. In the next section I describe the literature survey undertaken to inform the research question of this study. The purpose of this section is to locate my study within the field of research on school textbooks.

1.5 Literature review

My literature survey included a search of library databases (journals and books) as well as a search for research reports on the Internet. The search focused on analyses of school textbooks and the use of textbooks in classrooms. My initial search focused on mathematics school textbooks. This search yielded very few research reports and I subsequently broadened my research to focus on school textbooks in general. I have identified the following themes in the literature on school textbooks:

- Availability of textbooks
- Evaluation and selection of textbooks
- Analyses of textbooks
- The use of textbooks by learners and teachers in classrooms

1.5.1 Availability of textbooks

A common concern of studies relating to textbooks is the production, provisioning and availability of textbooks in schools. These studies vary from discussing issues relating to the production and availability of textbooks in the developing world in general (Farrel and Heynemann, 1989 cited in Czerniewicz et al, 2000; Altbach, 1983; Pearce, 1983) to specific case studies of particular countries (Gopinathan, 1983; Apieto, 1983; Taylor & Vinjevold, 1999 and Adler et al, 2001).

Although there has been no large-scale study on textbook provision in South Africa, in 1998 the Department of Education (DOE) established a task team to investigate the problems involved in textbook procurement and distribution processes in South Africa (Taylor & Vinjevold, 1999: 166). Taylor & Vinjevold (1999) reports that the DOE concluded that additional funding was required for textbooks and that:

> Although government increased the amount set aside for the delivery of textbooks and stationary, hitches in the planned provision are now well known and serve to demonstrate the difficulties of textbook provision in a vastly expanded educational system. (Taylor & Vinjevold, 1999: 166)

International and local studies point to the integral role of textbooks in the educational process. Altbach (1983) asserts that textbooks play a crucial role in the educational system, particularly in contexts where there is 'a shortage of teachers and where teacher training is limited in scope' (Altbach, 1983: 315).

However Czerniewicz et al (2000) argue that the literature on improving education in the developing world provides a false picture of the teacher/textbook debate (Czerniewicz et al, 2000: 42). This literature contends that it is more important for developing countries to invest a larger proportion of the education budget on textbooks than on salaries for teachers. For example, Farrell and Heynemann (1989) show that developing countries spend less on textbooks and produce lower primary science test results than developed countries. Farrell and Heynemann correlate expenditure on textbooks with learner achievement as evidence of their claims about the importance of textbooks in the educational process. However, Czerniewicz et al (2000) argue that this correlation is too simplistic since it excludes other variables which impact negatively on learner performance in poor socio-economic contexts.

The findings of the Taylor & Vinjevold (1999) suggest that textbooks are generally unavailable in South African schools and where textbooks are available there are insufficient textbooks for all learners. In relation to mathematics, Adler et al (2001) found that teachers in grades 7 and 9 had access to textbooks. In grade 7 there were sufficient books for all learners across all contexts. In grade 9, however, not all classrooms had sufficient textbooks for all learners. Adler et al (2001) attribute the difference in availability of textbooks in grade 7 and grade 9 to the current curriculum reform. They contend that since C2005 has been implemented in grade 7 and not grade 9, the provisioning of textbooks by government at grade 7 level has been stimulated.

Research on the availability of textbooks is not directly related to my study but clearly the availability of textbooks forms a necessary condition for learning and teaching in general and mathematics education in particular. However, a focus on the availability of textbooks alone is insufficient. We need a more in-depth study of how teachers use textbooks in classrooms as indicated, for example by Czerniewicz et al, 2000; Taylor & Vinjevold, 1999; Gopinathan, 1983 and Adler et al, 2001. Gopinathan (1983) asserts that 'a great deal more attention, both in educational research and teacher training, needs to be paid to ways in which curriculum materials are actually used in classrooms' (Gopinathan, 1983: 349). This is precisely the task of my study, which focuses on the use of textbooks in mathematics classrooms. In section 1.5.4, I examine local and international research on the use of textbooks in classrooms.

1.5.2 Evaluation and selection of textbooks

Two papers that comment on the public selection of textbooks are Wong (1991) and Czerniewicz et al (2000). Wong (1991) describes the public process of textbook selection in the United States of America. She contends that textbook selection committees follow a 'technical logic' in the selection process, thereby undermining the influence of interest groups on the decision-making process. Czerniewicz et al (2000) comment on the selection process in South Africa:

> Although the approval system is designed to keep out the outdated and inappropriate materials, it has the effect of undermining the very curriculum principles it seeks to support. Concerns include observations that the process of choosing evaluators is rushed and unsystematic, evaluators are poorly trained, the evaluation process is rushed, the instruments used for evaluation are inadequate, the criteria in checklists are inappropriately and inconsistently applied and that there tends to be reliance on technical criteria rather than on understanding of pedagogical principles. (Czerniewicz et al, 2000: 31)

Both papers point to a reliance on technical criteria for the evaluation of textbooks but do not provide criteria for the evaluation of textbooks. While Wong (1991) and Czerniewicz et al (2000) refer to national or regional selection committees and their adherence to technical criteria, Beattie (1986) provides criteria for teachers to evaluate textbooks.

Both articles by Wong (1991) and Beattie (1986) implicitly highlight the ideological nature of the evaluation of textbooks. Evaluation of textbooks is dependent on who the evaluators are and the criteria used to judge textbooks. A volume of essays edited by Apple and Christian-Smith (1991) focuses on the socio-economic conditions in the production and provisioning of textbooks and the ideological nature of textbooks. Similarly articles by Cairns & Inglis (1989), Heathcote (1982), Nibbelink et al (1986), Morehead (1984) deal with gender-bias in textbooks and Randolph-Robinson (1984) focuses on racism in textbooks. The literature on the evaluation of textbooks points to the need for systematic analysis of textbooks. This is dealt with in more detail in the section below.

1.5.3 Analyses of textbooks

Analyses of textbooks form a very broad category of literature. Analyses of texts in this literature range from content analysis to sociological analysis involving sophisticated languages of description. Two articles, which focus on content analysis enabling teachers to make choices about textbooks, are Freeman et al (1989) and Van Dormolen (1986). Neither article employs a systematic analytic framework but both are relevant to my study in that the analysis of the chapter of the textbook in my study includes an analysis of the mathematical content. However, in contrast to the content analysis of these articles, my study focuses on the sequence of mathematical concepts established by the textbook and considers how the chapter works as a whole rather than looking at discrete aspects of the text.

Fauvel (1991) analyses three mathematics texts in terms of pedagogy, mathematics, the ideal learner and the relationship between the learner and the author. Although Fauvel does not use a systematic analytic framework, the focus of his analyses of these textbooks closely links to the sub-questions posed as part of the research question of my study. My study focuses on the nature of the mathematics presented and the way in which mathematics is to be learnt, the behaviour of the learner and teacher and the relationship between the learner and teacher.

Dowling (1998) and Press (1999) have produced two studies that can be distinguished from the articles discussed above. Their studies employ systematic analytic frameworks to produce sociological analyses of mathematics texts.

Dowling (1998) analyses a secondary mathematics textbook scheme, SMP 11-16. He considers the Y-series and G-series as two texts within the textbook scheme intended for higher and lower ability students respectively. The focus of his analysis is on the differential form of mathematical knowledge distributed to lower and higher ability students. He concludes that the Y-series apprentices students into esoteric domain[12] practices while the G-series restricts students to the public domain, thereby effectively denying these students access to mathematics. He also shows how the Y-series student is associated with the professional middle class whereas in the G series the student is associated with the working class. Dowling's analysis of these mathematical texts includes a focus on the relationship between mathematics and other practices and particularly the way in which mathematics recontextualizes these practices in constituting a public domain.

Press's (1999) analysis of a chapter of a textbook focuses on the 'discursive effects that are produced by an extended text read as a whole, rather than by its discrete components' (Press, 1999: 104). She argues that it is for this reason that she did not employ the languages of description of Dowling (1998) and Halliday (cited in Press, 1999). Instead she used the semiotic methods of Eco (cited in Press, 1999) and Luke (cited in Press, 1999) and the social semiotic conceptual framework of Hodge and Kress (cited in Press, 1999) as tools in the analysis of a textbook chapter in order to identify the textual strategies used in the text, the literacy practices and narratives constructed by the text. Recruiting Hodge and Kress (cited in Press, 1999), Press (1999) argues that the discursive effect of any textbook is shaped by the context in which it is produced and used.

My study, like Press's (1999) study, is interested in uncovering the narratives in a textbook chapter as a whole. My study considered the narratives in the textbook on pedagogy, mathematics, and projected learner and teacher identities. My study differs significantly from both Dowling (1998) and Press (1999). In addition to an analysis of a chapter of the textbook, my study seeks to examine the ways in which teachers in mathematics

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[12] Dowling's notion of *domains* is discussed in more detail in Chapter 2.

classrooms use this textbook. In this way, my study extends the studies of Dowling (1998) and Press (1999) and captures the concern expressed by Gilbert (1989):

> [...] a more frequent concern among workers in this field [...] has been the reliance of such research on the analysis of texts removed from their context of use. The analysis of a text can point to potential, even likely, outcomes in the classroom, but it can never conclude with confidence that the ideological import of the text as interpreted by the researcher will be similarly realised in the discourse of the classroom. Reading practices of teachers and pupils are, as Luke, de Castell and Luke show in this collection (chapter 19), important processes in the production of textual meaning in the classroom. (Gilbert, 1989: 68)

Taking Gilbert's (1989) concern further, the next section examines literature that focuses on the use of textbooks in classrooms.

1.5.4 How textbooks are used in classrooms

The literature in this category is extremely limited and there are references to the paucity of this kind of research internationally and locally in South Africa (Czerniewicz et al, 2000; Taylor & Vinjevold, 1999).

A few studies, Ball & Feiman-Neimser (1988), Sosniak & Perlman (1990), Langhan (1993), Taylor & Vinjevold (1999), Adler et al (2001) and Mulcahy (1995) focus on the use of textbooks in the classroom. Of these works, Mulcahy (1995) is the only study that combines textual analysis and classroom-based research in considering the use of the textbook in the classroom. However, her study involves only two pages from a mathematics textbook. The extract from the textbook used in her study contains a short exposition on inequalities, three worked examples and an exercise. Her study is concerned with the control strategies employed by teachers in using textbooks in classrooms. She set out to examine the extent to which the teacher uses the textbook as a mechanism of control and the extent to which the teacher is controlled by the textbook.

Sosniak & Perlman (1990) explore how students perceive the use textbooks by teachers across different disciplines. Their study demonstrates that textbooks are used mainly for solving problems in mathematics and that students rarely read mathematics texts independently. Instead, students expect the teacher to explain the text to them. The study confirms that the use of textbooks is central to education in the United States and that textbooks are used differently in different subjects. This study concurs with studies relating to the use of textbooks and literacy practices of learners in South Africa (Taylor & Vinjevold, 1999; Adler et al, 2001; Czerniewicz et al, 2000 and Langhan, 1993).

Ball & Feiman-Neimser (1988) interrogated the notion that 'good teachers do not use textbooks' which formed the basis of the discourse of many American teacher education courses (Ball & Feiman-Neimser, 1988: 402). Their study analysed what the teacher education process conveyed about textbooks, planning and curricular decision making; what prospective teachers believed about the use of textbooks; and what these teachers did with textbooks and teacher guides in classrooms. Their study concludes that teacher education courses should prepare beginning teachers to use textbooks.

> As we discovered, telling prospective teachers not to follow textbooks or teachers' guides, but to be curriculum developers who create their own plans and materials, is not enough. Elementary teacher education students typically lack in-depth knowledge of any subject area. As novice teachers they also lack knowledge about children and are just starting to develop pedagogical orientation and skills. Developing ones "own" plans requires a flexible understanding of the content to be learned as well as ideas about how children might be helped to learn it. (Ball & Feiman-Neimser, 1988: 419- emphasis in the original)

Taylor and Vinjevold (1999), a compilation of research (PEI research) on South African classrooms, raise many issues relating to the use of textbooks in classrooms. Wickham & Versfeld claim in their study that teachers use 'textbooks in terms of their own coded practices rather than according the materials developers vision' (Taylor & Vinjevold, 1999: 171). However, the data in this study does not describe teachers' practices in detail. Baxen & Green found in their study that teachers mainly used textbooks themselves and that learners were given little or no opportunity for independent work with textbooks. They also found that textbooks were used 'to access existing knowledge on a topic and not to develop deeper conceptual understanding' (Taylor & Vinjevold, 1999: 173).

Taylor and Vinjevold (1999) cite a number of possible reasons why teachers are either not using textbooks at all or are using textbooks in limited ways in their classrooms: low levels of language competence amongst learners (and possibly teachers); teacher's poor level of content knowledge (see Langhan, 1993 and Pile & Smyth in Taylor & Vinjevold, 1999); perceived inconsistencies between textbooks and the requirements of C2005; and the fact that the role of textbooks in teaching and learning may have been undermined in teacher education courses.

Adler et al (2001) contest aspects of the research findings of Taylor and Vinjevold (1999) They claim that the PEI research findings are over-generalised[13] across contexts and subjects. Adler et al (2000) investigated the availability and use of written texts (textbooks, other material resources, and notebooks) across schools in different contexts and different grades. In particular, their study focused on textbook availability and use in grade 7 and grade 9 mathematics classrooms in Gauteng. Adler et al (2001) found that teachers in grades 7 and 9 made substantial use of textbooks in their mathematics classrooms and that teachers and learners particularly in grade 7 classes were more positive about their new textbooks than their old textbooks.

Besides the study by Mulcahy (1995), none of the other research cited above provides an analysis of the content of the textbooks themselves. Furthermore, the analysis of teachers' classroom practices in these studies does not provide a fine-grained account of the recontextualization of the textbook when incorporated into a teacher's classroom practice, as my study seeks to do.

This concludes the discussion on the literature reviewed for this dissertation. In the next section, I describe the structure of the dissertation.

1.6 Structure of the dissertation

Chapter 1 of this dissertation has described the motivation for this study, the particular research focus and the research question that emerged from this focus. The research question has further been refined into sub-questions which frame the design and analysis of the research. In addition, I have also presented a literature review that locates the dissertation in a body of research in the area of textbook production, analysis and use in classrooms.

Chapter 2 sets out the theoretical model that frames the analysis of the data collected for the dissertation. This chapter draws on the language of description of Dowling (1998) and Bernstein (1996) and Ensor's (1999) theoretical model of recontextualization.

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[13] Czerniewicz et al (2000), in a report on the role of LSMs in C2005, claim that until the time of study, there were few studies based on classroom observation and that wide disparities in contexts make generalisations problematic.

Chapter 3 locates my study within the main research study on textbooks and describes the research design of this dissertation, the instruments used for data collection, the data collected and the mode of data analysis.

Chapter 4 analyses a chapter of *Mfa7* LAB and the accompanying teacher's guide with respect to the ideal learner, ideal teacher, ideal classroom, the mathematical content and a privileged mode of teaching mathematics established in the textbook.

Chapter 5 and 6 analyses the data collected on the use of the textbook *Mfa7* LAB in Grade 7 mathematics teachers' classrooms and considers the nature of the recontextualization of the textbook.

Chapter 7 discusses the findings of the dissertation, the limitations and strengths of the study, and possible extensions and development of the study. In addition, this chapter focuses on recommendation on textbook design, the role of textbooks in teacher education, and curriculum and policy development with respect to textbooks.

Chapter 2

The generation of a theoretical model

2.1 Introduction

The central focus of this chapter is to set out the analytical framework of my study, from which I have derived the analytic tools for the analysis of data. As discussed in Chapter 1, the research question: '*What is the impact of Mfa7 LAB on Grade 7 mathematics teachers' classroom practice?*' requires a theoretical model that enables a systematic description of the recontextualization[1] of the textbook, *Mfa7* LAB, when it is incorporated into a teacher's classroom practice. This study focuses on the analysis of the privileged practices of the textbook and the relationship between the textbook and teachers' classroom practices.

Dowling's *Social Activity Theory* provides a theoretical framework for the discussion of recontextualizing. This theory was developed originally for the analysis of a school mathematics textbook scheme. In my own study, I have worked with Dowling's theory and its further use and development by Ensor (1999) who considers the recontextualization of pedagogic practices between a teacher education course and mathematics classroom teaching. Dowling's theory allows for an analysis both of textbooks and textbook use in classrooms since it provides tools for a discussion of modes of pedagogy and apprenticeship into pedagogic discourse, which are crucial to my study. In particular, Dowling's theory enables me to describe the positioning of acquirers by the textbook and by teachers in classrooms. In this chapter I start by describing Dowling's *Social Activity Theory* and then move to discuss the development of my theoretical model.

2.2 Social Activity Theory

Dowling's (1998) *Social Activity Theory* constructs a language of description for the sociological analysis of pedagogic texts. Dowling defines 'activity' as an analytic space

[1] The question of 'knowledge transfer' is linked to recontextualization. Both Davis (1995) and particularly Ensor (1999) consider the critiques on the discourse of knowledge transfer (Lave & Wenger, 1991; Carraher et al, 1985; Walkerdine, 1988, 1990). Ensor (1999) argues that although literature from a cognitive and developmental psychology perspective has challenged the notion that knowledge transfer between sites is unproblematic, these accounts do not take into account the production of subjectivity which is essential in a discussion on recontextualization (Ensor, 1999: 330-332).

that 'constitutes the contextualizing basis of all social and cultural practices' (Dowling, 1998: 131). Activities therefore produce and reproduce, (re)produce the division of labour in society and as such specialise positions and practices. In other words an activity regulates who is able to do, mean and say, and what can be said, done or meant. School mathematics can be regarded as an activity which specialises social identities (teachers and learners) and regulates what each appropriately can do. It also distributes different kinds of knowledge and practices to these social positions.

In Dowling's (1998) project, school mathematics is defined as the activity and two textbooks from the same textbook scheme and associated teachers' guides are taken as pedagogic texts which realise this activity. His analysis of these texts shows how they both constitute the activity of school mathematics and in turn are constituted by it.

Ensor (1999) adapted Dowling's model to develop a model for the description of recontextualization between a teacher education course and mathematics classroom teaching. This adaptation involved a number of aspects. Firstly, Ensor's model involved two distinct social activities, secondary mathematics initial teacher education and secondary school mathematics teaching, whereas Dowling's project considered a single social activity, school mathematics. Secondly, her study focused on transmitter texts (i.e. texts produced by teacher educators) as well as acquirer texts (i.e. texts produced by student teachers) whereas Dowling only focused on transmitter texts (the textbook scheme). In addition, Ensor considered non-pedagogic texts (e.g. interviews) which Dowling did not. The fourth and crucial distinction of Ensor's study is her focus on 'the institutional location of social activities which Dowling's own work productively signals but has not engaged with empirically' (Ensor, 1999: 333).

My study, like that of Dowling (1998), focuses on a single activity, school mathematics, but is more closely linked to Ensor's (1999) study both in research design and empirical setting. Like Ensor's study, the empirical focus of my study is partly located within classroom settings. In addition my study involves a range of texts, pedagogic and non-pedagogic. The development of the analytic model for my study evolved by working inductively and deductively with my own empirical data in relation to Ensor's model.

2.3 School Mathematics as an activity

School mathematics as an activity is concerned with the transmission and acquisition of school mathematics knowledge. The transmission and acquisition practices include the selection and sequencing of mathematical content to be acquired by learners, modes of teaching, learning and assessing mathematics, relationships between learners and teachers and forms of classroom organisation. While these transmission and acquisition practices are generic to school mathematics in general, variations in transmission and acquisition practices exist in different realisations of school mathematics (see Ensor, 1999: 64). For example, school mathematics is differently realised in 'traditional' forms of pedagogy than in 'progressive' forms of pedagogy, and within both of these further variations occur. It is therefore necessary to distinguish between school mathematics as an activity *in general* and different realisations of school mathematics *in particular*[2].

The activity of school mathematics, both in general and particular, incorporates three kinds of social actors or positions, *transmitters*, *acquirers* and *objectified* positions. These *positions*, which are specialised by the activity, are common to all realisations of school mathematics. (These *positions* are elaborated in section 2.6.) *Practices* however, vary across different realisations of school mathematics.

This study attempts to describe the recontextualization of pedagogic practices of the textbook *Mfa7* LAB when it is incorporated into Grade 7 mathematics teachers' classrooms. As such, this study focuses on school mathematics in particular, but the model opens up the analytic space to infer statements about school mathematics in general from statements about school mathematics in particular.

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[2] Ernest (1991) produced a typology which can be used to distinguish between different forms of school mathematics. He identifies five historical social interest groups: industrial trainers, technological pragmatists, old humanist, progressive educators and public educators. Different pedagogic practices can be associated with these groups. Industrial trainers and technological pragmatists adopt a utilitarian approach which regards mathematics as useful for society. Public educators view mathematics as a useful tool to critically evaluate and transform society. The old humanist and progressive educators view mathematics as an aesthetic subject worthy of study in its own right and as contributing to the development of the individual. Each of these ideologies produces different realisations of school mathematics.

2.4 School mathematics texts

School mathematics, as a social activity produces texts[3] and is reproduced through texts. School mathematics in *general* produces a range of different texts. These texts in turn (re)produce school mathematics in *general* and at the same time differentially (re)produce school mathematics in *particular*. Dowling asserts that an activity is only accessible via the texts produced within the activity. In other words, it is through an analysis of the texts of an activity that we can infer the positions specialised by the activity and the practices distributed to these positions.

This study focuses on two potentially different realisations of school mathematics, school mathematics as elaborated in the textbook, *Mfa7* LAB and school mathematics as realised in Grade 7 mathematics classrooms. These two instantiations of school mathematics occur in different sites of practice. For school mathematics as articulated in the textbook, the 'site of practice' is a *virtual classroom* constructed by the textbook. For school mathematics articulated by Grade 7 mathematics teachers, the site of practice is the *actual classroom*, which is the potential site for recontextualization of the textbook.

The texts considered in this study are the textbook, *Mfa7* LAB and the texts produced by teachers in Grade 7 mathematics classrooms. A textbook can be regarded as a potential pedagogic text for both teachers and learners. The primary concern of a textbook, as a pedagogic text for learners, is the transmission and acquisition of mathematics and a privileged mode of learning mathematics. The textbook, read intertextually with the accompanying teacher's guide[4], is potentially a pedagogic text for teachers insofar as it focuses on the transmission and acquisition of a privileged mode of teaching mathematics. The textbook can also potentially be considered as a pedagogic text for teachers in relation to mathematics content. In addition, a textbook can be considered as a potential resource which teachers recruit in the construction of their classroom practice.

[3] 'A text is an utterance (linguistic and/or non-linguistic) or set or sequence of utterances made within the context of one or more activities.' (Dowling, 1998: 131). For example, a text within the activity of school mathematics can include a classroom interaction between a learner and a teacher or between learners, written texts produced by learners or teachers or a textbook.

[4] In the past, many teacher's guides were mainly answer books. The guide as a pedagogic tool occurs most commonly in times of curriculum change.

2.5 Practices

School mathematics, as a social activity, is constituted by the practices of teachers and learners. Dowling distinguishes between activities and practices in two ways. Firstly, he distinguishes kinds of activities and practices on the basis of *discursive saturation* and secondly, on the basis of *domain*. These analytic categories are crucial in understanding how a textbook works as a pedagogic text and the extent to which it can successfully apprentice readers into its privileged forms of knowledge.

2.5.1 Practices and discursive saturation

Dowling uses the concept *discursive saturation* to differentiate between kinds of activities and practices. *Discursive saturation* describes the extent to which an activity or practice is realisable in language. Activities or practices such as school mathematics exhibiting high discursive saturation (DS+) are practices that are more or less fully realisable in language. In other words, school mathematics content can be transmitted and acquired to a large extent linguistically. DS+ activities and practices are relatively context-independent in that they can be generalised beyond the immediate site of practice. Such practices are able to make the principles of their regulation explicit within language. In contrast, activities or practices such as crafts, exhibiting low discursive saturation (DS-) are not fully realisable in language and they need to be transmitted through demonstration or modelling. These practices are relatively context-dependent and are tacitly regulated (Dowling, 1998: 30, 138).

The level of discursive saturation of practices, then, has important implications for pedagogy. DS+ activities and practices can be taught almost entirely linguistically. However, DS- activities and practices need to be taught on site through demonstration. This clearly has implications for the potential of a mathematics textbook to teach privileged ways of learning mathematics (to learners) and to teach privileged ways of teaching (to teachers). Ensor (1999) points to the limitations of Dowling's discursive saturation scale.

> Dowling dimensions discursive saturation according to a simple bipolar scale, a single distinction between DS+ and DS-. I want to extend this dimension in order to scale discursive saturation from DS++ (school mathematics) to DS⁻⁻ (for example, *mingei* pottery) to allow for a description of Practices which are not regulated in language to the same degree as mathematics but are potentially elaborated with greater specificity in the case of pottery. It then becomes

possible to describe the discursive Practices of mathematics teacher education in general varying along a dimension DS+ and DS-. (Ensor, 1999: 67 – italics in original)

Ensor argues that there are aspects of teacher education, for example, that are 'always tacitly regulated and which are not retrievable linguistically' and so teacher education should be considered as a hybrid of discursive practices (e.g. mathematics) and tacit practices (e.g. crafts) (Ensor, 1999: 68). Similarly, in relation to my own study, the transmission of a privileged mode of teaching and learning mathematics (privileged pedagogy) via a textbook cannot be achieved entirely linguistically. Aspects of the privileged pedagogy are most successfully transmitted and acquired if demonstrated practically. The transmission of a privileged pedagogy can therefore be considered as a hybrid of discursive and tacit practices.

2.5.2 Practices and domains

Within activities, Dowling differentiates between esoteric and public domain[5] texts. These domains can be described with respect to variations in the form of expression and content. The *esoteric domain* is strongly classified with respect to content and modes of expression and it is within the esoteric domain that the principles that regulate the activity can be marked out.

The public domain is weakly classified with respect to content and modes of expression. This domain is constituted through the recontextualizing gaze of the esoteric domain lighting upon external practices such as shopping or cooking. The public domain is always structured by the esoteric domain. Dowling also contends that the constitution of a public domain is crucial in the creation of apprentices to the activity. The public domain becomes the point of entry through which acquirers enter the activity.

In relation to school mathematics[6], a DS+ activity, the esoteric domain comprises abstract, principled knowledge. The public domain of school mathematics is constituted through the recontextualization of everyday practices (such as shopping, carpentry etc.) and it is the

[5] Dowling defines four domains of practice, esoteric, expressive, descriptive and public domains. For the purposes of this study I will only consider the esoteric and public domains.
[6] Here I am referring to the mathematical content knowledge to be acquired as opposed to the transmission of the privileged pedagogy (learning and teaching school mathematics).

portal through which apprentices enter the activity. An acquirer is expected to move from the public domain to the esoteric domain to become an apprentice. This is achieved through the use of generalising and specialising strategies, which provide the acquirer with access to principled, abstract mathematics. A dominance of proceduralising, fragmenting and localising strategies is likely to prevent the acquirer from moving beyond the public domain, thus inhibiting apprenticeship into the activity.

A school mathematics textbook, incorporating as it does DS+ mathematics, can potentially make available to acquirers the principled knowledge they require to produce mathematical statements independently that is, to achieve apprenticeship. However, making available a privileged pedagogy via a textbook and/or teacher's guide is a different matter. My argument here (following Ensor, 1999) is that teacher education (making available to teachers privileged forms of pedagogy) is a hybrid of both DS+ and DS- practices. These need to be made available by means of explicit discussion and demonstration in the site of practice, the school classroom.

2.6 Positions

The activity of school mathematics, in general and particular, constructs three positions, *transmitter*, *acquirer* and *objectified* positions. The *objectified position* is located outside the activity of school mathematics. Non-mathematics teachers and parents for example, constitute objectified positions with respect to school mathematics. I will now consider these positions for school mathematics firstly as embodied in the textbook *Mfa7* LAB and secondly as enacted in Grade 7 mathematics teachers' classrooms.

2.6.1 Positions produced by the textbook Mfa7 LAB:

A textbook constructs authors as *transmitters* and readers as *acquirers*. The textbook on its own can be considered as a pedagogic text for learners where the primary concern is the transmission and acquisition of mathematics and a privileged mode of learning mathematics. However, the textbook, read intertextually with the accompanying teacher's guide, is *potentially* a pedagogic text for teachers where the focus is on the transmission of a privileged mode of teaching mathematics. Both teachers and learners can therefore be considered as acquirers.

Textbooks both in general and in particular construct an ideal teacher and an ideal learner to whom the privileged practices (mathematics and pedagogy) are distributed. Pedagogic activities such as school mathematics also construct hierarchies of acquirers. This study focuses on establishing how the ideal teacher and ideal learner are constructed, as well as a hierarchy of acquirer positions, which is discussed below.

The first acquirer position I discuss is that of the *apprentice* position. For the ideal teacher or ideal learner to be constructed as an apprentice, the principles for the production of the privileged practices must be distributed to him/her. This is the concern of Chapter 4 which considers the extent to which mathematics and the privileged pedagogy of the textbook, *Mfa7* LAB and associated TRB, are made available to teachers and learners.

According to Dowling, apprenticeship is contingent on access to the principles regulating the activity. If learners are not given access to the principles of the activity, they are constituted as *dependent*. This can happen in two ways. Learners may be presented with mathematics in the form of algorithms and procedures, or with mathematics which does not extend much beyond public domain text. In other words, learners are denied access to the systematic complexity of mathematics. Similarly, for teachers to be apprenticed into privileged forms of pedagogy, they need access to the principles of production of this privileged pedagogy. Dowling's distinction between *apprentice* and *dependent* positions is limited in that that it does not allow for differential levels of acquisition between these two positions. I now turn to Bernstein's concepts, *recognition* and *realization rules* which will be used as analytic tools to elaborate on Dowling's levels of acquisition (see Ensor, 1999: 72).

Bernstein (1996) refers to *recognition rules* as the means by which individuals are able to 'recognise the speciality of the context they are in' (Bernstein, 1996: 31) and *realization rules* as the means whereby individuals 'produce the legitimate text' (Bernstein, 1996: 32). In other words, the individual who possesses recognition rules knows what is required and can recognise an appropriate response. Individuals who possess realization rules are able to produce utterances which are considered legitimate within a specific context. In other words, an individual knows how to reproduce pedagogic discourse. Learners, who only possess recognition rules of mathematics, can recognise what kind of response is appropriate to a context but they may not know how to produce it. For this learners require access to the realization rules of mathematics. Consider the mathematics task below:

> Sedica wants to tile the top of a counter next to the kitchen sink. The top of the counter is 100 cm wide and 80 cm long. The tiles she wants to use are 10 cm long and 10 cm wide. How many tiles are needed to cover this area? (*Mfa7* LAB: 78)

In the above mathematical task, learners have to recognise what kind of mathematics response is required which in this case involves area of rectangles (recognition rules) and the learner is required to successfully solve the problem (realization rules).

With respect to the transmission of a privileged pedagogy, access to the recognition rules enable acquirers (in this case teachers) to describe the privileged pedagogy discursively. Access to realization rules enables acquirers (in this case teachers) to implement the privileged pedagogy in classrooms (Ensor, 1999: 71).

Following Ensor (1999), Bernstein's concepts allow for the introduction of two more positions within the hierarchy of acquirer positions that of the *initiate* (Ensor, 1999: 72) and the *novice*. These positions are now considered in relation to teachers and learners as acquirers.

2.6.1.1 The textbook as a pedagogic text for teachers

For teachers as acquirers, the *apprentice* teacher has the capacity to (re)produce the practices of the activity which, in the case of my study, means being able to teach mathematics as privileged by the textbook. The apprentice teacher therefore must be recruited into the regulative principles of the privileged pedagogy to enable this teacher to (re)produce the activity. The apprentice teacher requires access to the recognition as well as the realization rules of both the discursive and tacit aspects of the privileged pedagogy. In contrast, the *dependent* teacher is denied access to the regulative principles of the privileged pedagogy with respect to the discursive and tacit aspects. The dependent teacher lacks the capacity to (re)produce the activity. In other words, this teacher is incapable of teaching mathematics as privileged by the textbook. The dependent teacher is not given access to the recognition rules nor the realization rules in order to (re)produce the activity.

The next acquirer position discussed is that of the *initiate* which is derived from Ensor's (1999) study. The *initiate* has access to descriptions of the privileged mode of teaching but not to the principles for reproducing this mode of teaching mathematics. The *initiate* is capable of describing the privileged mode of teaching but is unable to implement this pedagogy successfully in the classroom. The *initiate* therefore has access to the recognition rules but not the realization rules.

I have found the need to develop Dowling and Ensor's categories further. Any teacher, who demonstrates aspects of apprenticeship and dependency, I will describe as a *novice*. The *novice* position can be considered as a teacher who has partial access to the principles of the privileged mode of teaching mathematics and as such has partial access to the recognition and realization rules. The *novice* is capable of producing aspects of the privileged mode of teaching mathematics. The degree to which a *novice* is capable of reproducing the activity cannot be determined theoretically. This can only be established empirically. For example, a teacher may be able to use a learner-centred pedagogy successfully but may not know aspects of the mathematical content knowledge that has to be taught.

Table 2.1 below summarises the positions constructed by the textbook for teachers as acquirers.

Table 2.1 Hierarchy of ideal teacher positions constructed by textbook

Ideal teacher	**Located in the activity of school mathematics**	**Access to recognition rules of the activity**	**Access to realization rules of the activity**
apprentice	yes	yes	yes
initiate	yes	yes	no
dependent	yes	no	no
objectified *	no	not applicable	not applicable
novice	yes	partial	partial

* out

2.6.1.2 The textbook as a pedagogic text for learners

Similarly, the textbook constructs an ideal learner who can occupy a number of acquirer positions within the hierarchy, *apprentice, novice, initiate* and *dependent* positions. The *apprentice* learner has the potential of becoming the subject of school mathematics. The apprentice learner requires access to the principles of the mathematics presented in the textbook so that s/he can (re)produce the practices of the activity, school mathematics. The apprentice learner therefore must be recruited into the regulative principles of mathematics, to gain access to the recognition and realization rules of mathematics. The *dependent* learner, on the other hand, is denied access to the principles of mathematics, and is not given access to the recognition nor the realization rules of mathematics. The *initiate* has access to the recognition rules but not the realization rules; s/he can recognise appropriate mathematical responses but cannot actually reproduce them independently of a teacher.

Any learner, who demonstrates aspects of apprenticeship and dependency, I will describe as a *novice*. The *novice* position is capable of producing aspects of mathematics. For example, a learner may be able to reproduce mathematical algorithms but may not necessarily be able to explain the underlying principles of the procedure or the learner recognises and can reproduce correct responses for particular mathematical topics but not others. The *novice* is thus given partial access to the recognition and realization rules.

Table 2.2 below summarises the above discussion on the hierarchy of positions constructed by the textbook for learners as acquirers.

Table 2.2 Hierarchy of ideal learner positions constructed by textbook

Ideal learner	Located in the activity of school mathematics	Access to recognition rules of the school mathematics	Access to realization rules of the school mathematics
apprentice	yes	yes	yes
initiate	yes	yes	no
dependent	yes	no	no
objectified	no	not applicable	not applicable
novice	yes	partial	partial

2.6.2 Positions constructed by Grade 7 mathematics classroom practice

Grade 7 mathematics teaching constitutes a particular realisation of school mathematics. Of concern for this study is the relationship between teachers and the practices of the textbook and the realisation of this relationship in the classroom. This study describes how Grade 7 mathematics teachers recontextualize the ideal pedagogy and content of the textbook when they incorporate it into their classroom practice. Teachers may identify with the practices of the textbook and attempt to reproduce the activity of school mathematics as embodied in the textbook. On the other hand, teachers may not identify with the practices of the textbook and in so doing objectify the activity of school mathematics as embodied in the textbook. Consequently, the *teacher positions* constituted by Grade 7 mathematics teaching depend on whether the teacher identifies with or objectifies the practices of the textbook. Two positions, *affiliators* and *objectifiers,* can be identified (Ensor, 1999: 76).

The *affiliator teacher positions* are those which identify with the textbook's pedagogic practices. The *affiliator* attempts to reproduce school mathematics as articulated in the textbook. The apprentice, novice, initiate and dependent positions are sub-types of the affiliator position.

The *apprentice affiliator position* identifies with the practices of the textbook and constitutes his/her teaching practice by recruiting from the practices privileged by the textbook. This teacher recognises the practices preferred by the textbook and is capable of implementing these practices in the classroom. In other words, the apprentice fully demonstrates the recognition and realisation rules of the privileged mode of teaching mathematics inscribed in the textbook.

The *initiate affiliator position* identifies with the practices of the textbook and is able to describe the privileged practices of the textbook but is unable to implement these practices. This teacher demonstrates access to the recognition, but not the realization rules of the textbook.

The *dependent affiliator position*, like that of the apprentice, identifies with the practices of the textbook and attempts to constitute his/her teaching practice by recruiting from the practices privileged by the textbook. The dependent teacher lacks the facility to reproduce the practices of the textbook and is therefore not capable of effectively implementing these practices in the classroom. As such, the dependent position lacks both the recognition and realization rules of the practices of the textbook.

The *novice affiliator position*, like that of the apprentice, identifies with the practices of the textbook and constitutes his/her teaching practice by recruiting from the practices privileged by the textbook. However, relative to the apprentice position, the novice is a subordinate position. The *novice* teacher partially reproduces the practices of the textbook and therefore partially demonstrates the recognition and realisation rules of the textbook.

The *objectifier* teacher positions do not identify with practices of the textbook and may identify with other school mathematics teaching practices. The objectifiers locate the principles of evaluation of their teaching practice as different from those privileged by the textbook. They may use the textbook as a potential resource in the construction of their pedagogic practice. Two sub-types of the objectifier position, *positive objectifier* and *negative objectifier* positions can be marked out (Ensor, 1999: 77).

Positive objectifiers selectively recruit from the textbook to constitute their own practice. The textbook is viewed as one of a collection of resources which such a teacher might draw on. As such, these teachers tend to fragment the practices of the textbook in constituting their own practice. The *negative objectifier* is a teacher who rejects the textbook as a potential resource in the construction of his/her own pedagogic practices. The practices of the textbook are to a large extent considered unsuitable for selection.

2.7 Apprenticeship and framing

For Dowling, a text constructs a reader as an apprentice by making esoteric domain knowledge available through generalising and specialising strategies. In my study, since I am not only analysing a textbook as a pedagogic text but also examining how this textbook is used in classrooms, I needed to incorporate *framing* as a category of analysis. Bernstein (1996) refers to *framing* as the regulation of control on communication within forms of interaction. He further refers to framing as 'the nature of the control over': NB

> - the selection of communication;
> - its sequencing
> - its pacing (rate of expected acquisition);
> - the criteria;
> - the control over the social base which makes the transmission possible. (Bernstein, 1996: 27)

Framing therefore describes the location and nature of control in pedagogic relations. In this study, framing will be used to describe control relationships between teachers and learners and the control that teachers and learners have over the selection, pacing, sequencing and organisation of mathematics.

2.8 Summary of the model

Figure 2.1 below illustrates the different aspects of the analytic model that enables a description of the recontextualization of pedagogic practices from a textbook to teachers' classroom practice. Tables 2.3 and 2.4 show the *positions* and *practices* of teachers and learners in two different realisations of school mathematics, the textbook *Mfa7* LAB and mathematics classroom teaching respectively.

Figure 2.1: School mathematics in general and in particular

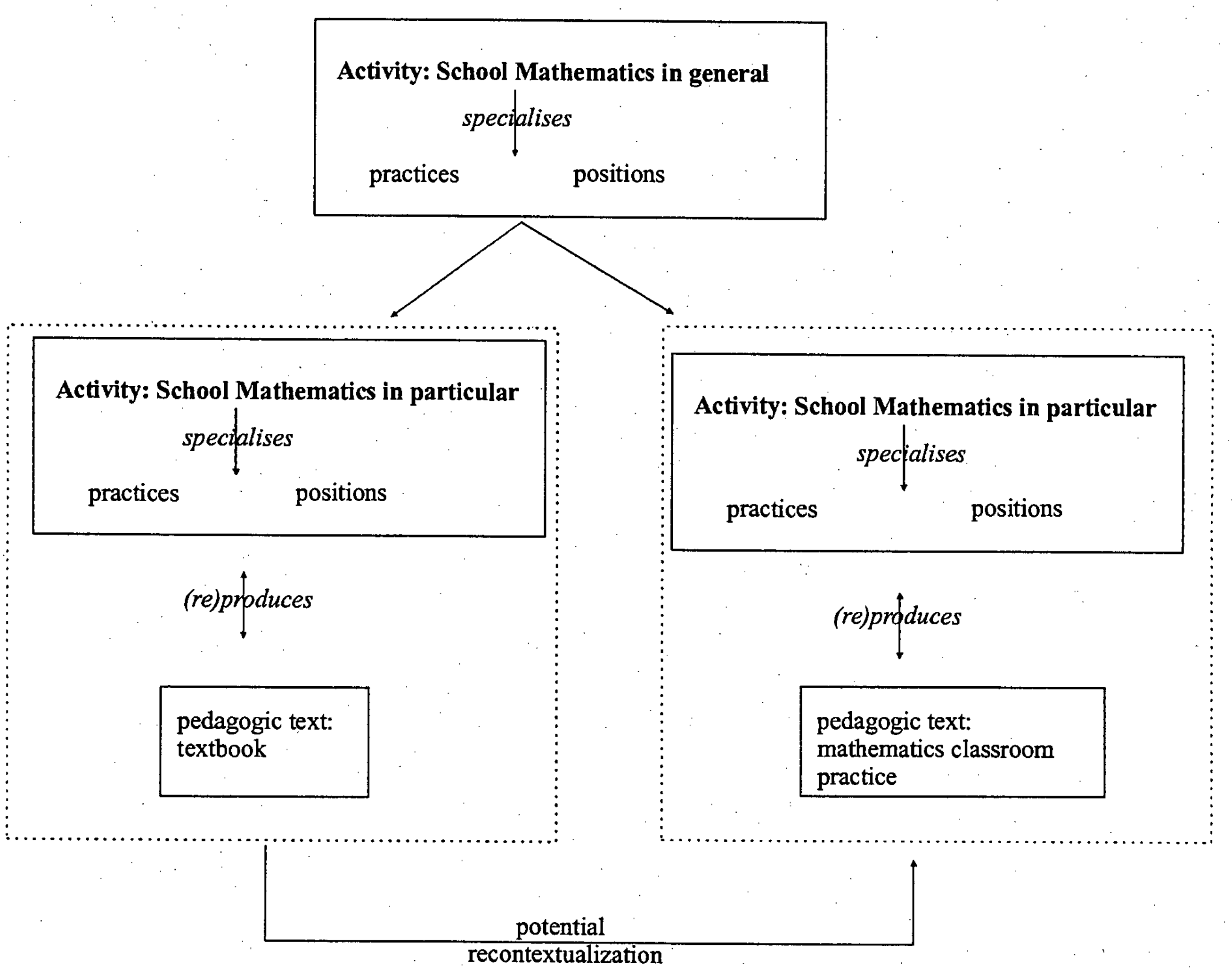

Table 2.3 Positions and practices constructed by textbook *Mfa7* LAB

Activity: School Mathematics in particular **Text:** *Mfa7* LAB	
Site of Practice: Virtual/ textual mathematics classroom	
Position	**practice**
Ideal teacher:	
apprentice	Full access to principles of privileged mode of teaching mathematics. Provided with full access to recognition and realisation rules of privileged practice.
initiate	Able to describe privileged practice of textbook but unable to implement these practices. Provided with access to recognition and but not to realisation rules of privileged practice.
dependent	Denied access to principles of privileged mode of teaching mathematics. Not provided with access to recognition and realisation rules of privileged practice
novice	Partial access to principles of privileged mode of teaching mathematics. Provided with partial access to recognition and realisation rules of privileged practice.
Ideal learner	
apprentice	Full access to access to principles of mathematics. Provided with full access to recognition and realisation rules of mathematics
initiate	Able to recognise appropriate mathematical responses but unable to reproduce appropriate mathematical responses. Provided with access to recognition and but not to realisation rules of mathematics.
dependent	Denied access to principles of mathematics. Not provided with access to recognition and realisation rules of privileged practice.
novice	Partial access to principles of mathematics. Provided with partial access to recognition and realisation rules of mathematics.

Table 2.4 Positions and practices constructed by mathematics classroom teaching

Activity: School Mathematics in particular **Text:** mathematics teaching	
Site of Practice: Actual primary mathematics classroom	
Positions	**practices**
Affiliator teacher position:	Identifies with practices privileged by textbook.
apprentice	Fully demonstrates principles of privileged mode of teaching mathematics. Demonstrates recognition and realisation rules of privileged practice of the textbook.
initiate	Able to describe privileged practices of textbook but unable to implement these practices. Demonstrates recognition rules but not the realization rules of the privileged practice of the textbook.
dependent	Does not demonstrate principles of privileged mode of teaching mathematics. Does not demonstrate recognition and realisation rules of privileged practice of the textbook.
novice	Partially demonstrates principles of privileged mode of teaching mathematics. Provided with partial access to recognition and realisation rules of privileged practice of the textbook.
Objectifier teacher position:	Does not identify with practices privileged by textbook.
positive	Constitutes individual teaching practice by selective recruitment from practices privileged by textbook.
negative	Little if any practices privileged by textbook recruited in the constitution of individual teaching practice.
Learner positions:	
apprentice	Fully demonstrates principles of mathematics. Demonstrates recognition and realisation rules of mathematics
initiate	Demonstrates recognition but not realization rules of mathematics
dependent	Does not demonstrate principles of mathematics. Does not demonstrate recognition and realisation rules of mathematics.
novice	Partially demonstrates principles of mathematics. Partially demonstrates recognition and realisation rules of mathematics

2.9 Conclusion

This chapter focused on the production of an analytic framework for the description of the recontextualizing of pedagogic practices inscribed within a textbook to Grade 7 mathematics teacher's classroom practice. The analytical framework is a development of Ensor's (1999) model of recontextualization, an extension of Dowling's (1998) Social Activity theory.

In chapter 4, 5 and 6, the analytical framework developed here is applied to the data to develop a more detailed description of the research study which focuses on:

- the transmission and acquisition of mathematics and a privileged mode of teaching mathematics inscribed within the textbook *Maths for all* Grade 7 LAB, and the text's construction of the ideal teacher, ideal learner and ideal classroom.
- the construction of grade 7 mathematics teachers' classroom practices, the teachers' construction of learners and mathematics and the extent and form of recontextualization from the textbook.

The model produced in this chapter delineates a powerful theoretical tool which enables a single mode of analysis to be applied to a range of texts. It enables the analysis of the mode of construction of pedagogic texts and the extent to which the texts apprentice learners. In addition, the model allows for the description of the recontextualizing of pedagogic practices from the privileged practice.

Chapter 4 focuses on the analysis of a chapter from *Mfa7* LAB and the associated chapter from *Mfa7* TRB. Chapter 5 and 6 considers the analysis of the data collected on teachers' use of the textbook *Maths for all* Learner's Activity Book for grade 7.

The next chapter locates my study within the main research study on textbooks and describes the research design, instruments used for data collection, the data collected and the mode of analysis.

Chapter 3

Research design and context of the study

3.1 Introduction

The central focus of this chapter is to describe the research design of my study, the data collected and the instruments used to address the research question, *What is the impact of Mfa7 LAB on Grade 7 mathematics teachers' classroom practice?* In addition the research design of the main research project and the context of the study is also discussed[1]. The main research project is in the process of completion and my study forms an important component of the overall research report.

3.2 The main research project

3.2.1 Research design of main project

The main research project takes the form of a small-scale study of the ways that the textbook practices impact on teachers' teaching of mathematics to their Grade 7 learners, and on learners' learning in these classes. A quasi-experimental design was used in conjunction with qualitative data collection strategies. The research project develops a model that makes it possible to investigate the effectiveness of *Mfa7* LAB's textbook content and pedagogy in assisting teachers to mediate appropriate knowledge and learning outcomes. The initial research design was based on that piloted in Focus on Seven (Reeves & Long, 1998b), a classroom based research study commissioned by the President's Education Initiative (PEI), which was strongly influenced by the TIMSS (Third International Mathematics and Science Study) research.

The design of the research project included:

- random sampling to constitute a sample of initially 12 ex-DET schools in Cape Town. (This was later reduced to 14 grade 7 classrooms.)

[1] I will use the term 'my study' to refer to my own research and the term 'research project' to refer to the main research project of which my study forms a component.

- random allocation of classes into experimental and control groups, with experimental classes receiving textbooks at the start of the project
- pre- and post-testing of learners' mathematical achievement
- one lesson observation of each of the 14 teachers, which was video-recorded
- interviews with the sample of teachers
- questionnaires (learner, teacher and school)
- *Mfa7* LAB and TRB provided at the beginning of research project to experimental teachers
- a comparison of pre- and post-test results of the sample using statistical methods

3.2.2 Sample of main research project

A Western Cape Education Department list of 80 ex-DET schools in the Cape Peninsula was used to generate a random sample of 12 schools. Two schools were eliminated from the initial sample. The first school was eliminated because preliminary visits to the schools revealed that conditions at this school were such that formal teaching and learning did not appear to take place on a regular basis. The second school was not located within easy travelling distance from the rest of the schools as the other randomly selected schools.

Initially, the plan was to have an experimental and control class at each school. However, we found that that only two of the randomly selected schools had two Grade 7 teachers. This meant that it was not possible to have a control and experimental teacher at each school. One teacher each from both of these schools agreed to be part of the control group. Three other schools that were not randomly selected, in close proximity to the schools selected as sites for the study, were approached to form part of the control group. At the beginning of the second term of 2000, a teacher at one of these schools decided not to participate as the school had decided not to cover the proposed topics in the second term. The project thus involved 14 teachers at 12 schools which were generally representative of the majority of traditionally black primary schools in the Western Cape. These teachers included 10 experimental and 4 control teachers.

3.2.3 Data collection of main research project

The following data was collected for the main research project:

1. The textbook chapters

In consultation with the teachers, the research project decided to focus on measurement (length, area and perimeter) and decimals and percentages which the teachers were requested to teach in the second term of 2000. For the experimental teachers these two topics corresponded to Chapter 4 (Measurement) and Chapter 7 (Decimals and percentages) respectively in the *Maths for all* Grade 7 LAB. It was negotiated with the control teachers that they would complete the same topics requested from the experimental teachers.

Each experimental teacher was given a class set of the grade 7 *Maths for all* Learner's Activity Books (LAB) and a Teacher's Resource Book (TRB) at the beginning of 2000. These books were donated to the schools and have become their property. The control teachers were not supplied with textbooks at the beginning of the research project but were each given a class set of LABs and a TRB on completion of the data collection.

The experimental teachers were not provided with any training on how to use the textbook in the classroom because the intention of the project was to see how teachers in mathematics classrooms would use the textbook without such support. All teachers were invited to a series of workshops after the completion of data collection to discuss the textbooks and the results of the achievement tests.

2. Teacher questionnaires

Fieldworkers administered two teacher questionnaires to teachers in the research project. The first teacher questionnaire, *Teacher questionnaire 1: Preliminary survey of grade 7 mathematics curriculum information for second term 2000*, was administered to teachers at the end of 1999 (see Appendix 3.1). This questionnaire was to establish which curriculum documents, mathematics textbooks or other curricula material teachers would use in the teaching of mathematics at grade 7 level. In addition, the questionnaire set out to establish the language(s) of instruction used in grade 7 mathematics classes and the extent of teacher's involvement in INSET over the past 5 years. At the time of administering the questionnaire, none of the teachers was involved in any mathematics INSET, although they all had had some form of INSET experience in the past.

The second teacher questionnaire, Teacher questionnaire 2 (see Appendix 3.2) was administered in April 2000. This questionnaire sought to establish the teachers' academic and professional background, the teachers' classroom practices, particularly their use of textbooks, their attitudes towards teaching mathematics and information about the grade 7 class involved in the research.

3. School questionnaire

Fieldworkers administered a school questionnaire on the same day as the second teacher questionnaire. The school questionnaire (see Appendix 3.3) completed by the school principal, focused on the physical profile of school, information about numbers of learners and teachers, and information about the home background of learners.

4. Learner questionnaire

The fieldworkers administered two learner questionnaires to the classes of the teachers involved in the research project. The questionnaires, adapted from the TIMSS learner questionnaire, was designed to establish changes in learners' perceptions about the value of mathematics, how learners perceived their own success in mathematics and their ideas about abilities necessary to succeed in mathematics.

5. Classroom observation

An observation schedule (see Appendix 3.4) included criteria and a coding scheme on a continuum that was intended to measure the different levels at which individual teachers used the textbook content and pedagogy to engage learners with the intended learning goals. The observation schedule was completed while observing the teachers teach. I completed the schedules while a senior researcher video-recorded the lesson. The schedule was useful in recording locational aspects of the setting and for focussing observation on the lesson. The video-recordings are important as long term records of the lesson. I observed 13 of the 14 teachers in the research project.

6. Interview

Fieldworkers engaged by the main research project conducted a structured interview (see Appendix 3.5) with all 14 teachers in June 2000. The interview took place after the observation of lessons of all teachers had been completed and on the same day that the post-tests were carried out at the schools. The teacher interview schedule was used as a mechanism for establishing the teacher's coverage of the relevant topic/textbook chapters. The structured interviews helped to establish teachers' estimates of the number of lessons in which the topic/chapters were covered and the reasons why many did not manage to cover these topics. Teachers were also asked to respond to questions about their use of *Mfa7* LAB and *Mfa7* TRB, the use of other textbooks and their opinions of *Mfa7* LAB and *Mfa7* TRB. In addition, they were asked how they expected their classes to perform on the post-tests.

7. Pre- and Post learner tests.

A pre- and post-test based on measurement and decimals and percentages were administered to the learners in the 14 classes which formed part of the project. The pre-test took place in April 2000 and the post-test took place in June 2000, towards the end of the second term. Some of the test items were drawn from TIMSS.

3.3 My study

This section contains a brief description of my study, the relation to the main research project, its particular research focus, the sample I worked with, the data collected and mode of analysis adopted for my study.

3.3.1 Description of my study

This thesis seeks to answer the question, *What is the impact of Mfa7 LAB on Grade 7 mathematics teachers' classroom practice.* The central focus of this study is the recontextualization from a textbook when incorporated into teachers' classroom practice.

This research question can be elaborated by two further questions:

- What is the nature of the pedagogy privileged in *Mfa7* LAB and associated Teacher's Resource Book (TRB)?
- How do teachers in mathematics classrooms use this textbook?

The central focus of my study is therefore on teachers and not learners and therefore relates to the teacher focus of the main research project. The learner tests and learner questionnaires are therefore not directly relevant to my study. The data collected for the main research project was useful for my purposes but the data set was too large for a study of this kind. In addition, I realised that I needed to collect additional data since the data collected by the main research project was insufficient to answer my research question. I therefore needed a mechanism to select a smaller sample of teachers and collect more in-depth data.

3.3.2 Sample of my study

The first selection of teachers I made was based on an existing division between control and experimental teachers. Since I was interested in how teachers used the *Maths for all* textbook, I decided to focus on the experimental group of teachers only. These teachers all had access to the *Maths for all* LAB and they agreed to use the *Maths for all* LAB to teach measurement, decimals and percentages in the second term of the year of the study.

Based on the above selection strategy, I reduced the number of teachers from 14 to 10. However, this group of 10 experimental teachers was still too large for my study. A second selection was made on the basis of topics covered by teachers in their observation lesson. An examination of the lessons, revealed that four of the teachers taught lessons on measurement and six teachers taught lessons on fractions. The lessons on fractions ranged from introduction to fractions, operations on fractions to decimals and percentages[2]. Only one of these teachers taught a lesson on decimals that was directly linked to Chapter 7 of the *Mfa7* LAB. All the other teacher's lessons based on fractions did not match the content of the Chapter 7 from the *Mfa7* LAB which the teachers were requested to teach.

Since my study involved an analysis of how the *Mfa7* LAB was used in classrooms, I needed to focus on those teachers who taught sections of work which were directly related to the chapters in the *Maths for all* LAB. This was the case for teachers who taught measurement. I therefore excluded the teachers who taught fractions and reduced my sample to the four teachers who taught measurement (length, area and perimeter).

[2] It appeared that the teaching of decimals and percentages in the second term was problematic for many teachers since this section depended on learners' knowledge of fractions. Due to teacher's pacing or contextual factors at the individual schools, many teachers were unable to teach decimals and percentages by the time the researchers observed the lessons.

3.3.3 Data Collection for my study

For the four teachers, I used the data collected as part of the main research project, in which I was involved. In particular I used the questionnaires (teacher and school), interview data, part 1 of the observation schedule[3] and video-recordings of lessons. In addition to the above-mentioned data, I collected further data for these four teachers. The additional data set I collected was as follows:

1. Interview

I conducted a second interview with the teachers, which was explicitly linked to the video-recorded lessons. Since the first interview focused mainly on the teacher's use of textbooks, particularly *Mfa7* LAB, the second interview was an opportunity for teachers to explain their actions in the video-recorded lessons. This interview was semi-structured and the interview schedule is contained in Appendix 3.6. A large part of the interview was based on showing teachers extracts from the video and posing specific questions in relation to these. The interview schedules for the different teachers contained a set of core questions that I asked all teachers, as well as questions specific to each teacher.

2. Learner Notebooks

The interviews and video-recorded lessons provided insights into teachers' preferred teaching styles and the way in which they used *Mfa7* LAB. However, I was also interested in teachers' design of their lessons on measurement, the extent to which *Mfa7* LAB was used and how it was recontextualized as part of each teacher's practice. Teachers' descriptions of tasks used from *Mfa7* LAB in the interviews did not provide sufficient information about the design of the teaching of measurement. I decided to collect learner notebooks for further information on tasks used from *Mfa7* LAB, the sequencing of content, and the extent of usage of the textbook. The notebooks thus served to triangulate teachers' accounts in the interviews and observations of their lessons.

I collected six learner notebooks from each teacher. From each teacher, I requested three notebooks of their strongest learners and three of their weakest learners so as to obtain a spread of notebooks according to levels of performance. However, I did not intend to use

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[3] I did not use part 2 of the observation schedule because it contained criteria for evaluating teachers' classroom practice which differed from the theoretical framework which I have used for the analysis of data.

the notebooks as indices of learners' performance. Rather, the notebooks were intended to serve as secondary mirrors from which to read off the teacher's structuring of the pedagogic discourse[4]. Here I was less interested in the differences between different learner's notebooks, but in establishing a composite picture of the teacher's structuring of the teaching of measurement. One notebook per teacher would therefore not have been sufficient since learners would not necessarily record entries in their notebooks on days they are absent from school. Having more than one notebook therefore allowed me to piece together each teacher's design of teaching measurement by checking across different notebooks. Composite descriptions of the day-to-day entries for the measurement topic for each teacher are contained in Appendix 5.2, 5.4, 6.2 and 6.4. In Table 3.1 below, I summarise of the data collected for my research project.

Table 3.1 Summary of data collected

Data	Collected by	Nature of the data
Mfa7 LAB, chapter 4 and accompanying TRB	Not applicable	Pedagogic texts provide insights into privileged pedagogy and developmental trajectory.
Teacher questionnaire 1	Fieldworkers	Information about textbooks and other curricula material teachers planned to use in teaching grade 7 mathematics, teacher's current involvement in INSET.
Teacher questionnaire 2	Fieldworkers	Information about teachers' academic and professional background, their use of textbooks, attitudes towards teaching mathematics, information about their learners.
School questionnaire	Fieldworkers	Information about the physical profile of school, numbers of learners and teachers, home background of learners
Interview 1	Fieldworkers	Information about teacher's preferred pedagogy and use of textbooks
Interview 2	SJ	Information about video-recorded lesson and use of *Mfa7* LAB
Video-recorded lesson and observation schedule (part 1)	Senior researcher and SJ	Information and insight into teacher's pedagogy using *Mfa7* LAB
Learner notebooks	SJ	Learner texts read in order to access teacher's structuring of the pedagogic discourse to provide insight into teacher's pedagogy, use of textbooks and developmental trajectory.

3.3.4 Mode of analysis

The analysis of the data contained in Chapter 4, 5 and 6 can be described as largely qualitative. The analysis of the data, based on the model described in the previous chapter, proceeded by moving inductively from the data to the theory and deductively from the

[4] The use of learner notebooks in my study concurs with Adler & Reed (2000) who argue that:

> Learner books are not direct indicators of learner performance. They nevertheless can reflect the kind of mathematics, [...] valued by teachers through inscription and attempts at practice and mastery. (Adler & Reed, 2000: 213)

theory to the data (Dowling, 1998 and Dowling and Brown, 1998). In other words, the model was derived from a theoretical framework in dialogue with a data set.

1. Analysis of textbook chapters

I based the analysis of *Mfa7* LAB on the method of 'close and comparative' (Dowling, 1998: 190) reading used by Dowling in his sociological analysis of SMP texts. A 'close' reading entails following the order of the empirical text to generate the analysis. In contrast to Dowling, however, I did not compare the *Mfa7* LAB to any other pedagogic texts. *Mfa7* TRB was read intertextually with *Mfa7* LAB. Although the analysis followed the order of the empirical texts, the presentation of the analysis in Chapter 4 is organised into a detailed analysis of the first two activities followed by a discussion of themes which emerged from the analysis of the text.

2. Analysis of interview transcripts

The interviews, video-recordings and learner notebooks were initially analysed separately. In presentation of the data on the teacher's use of textbooks, however, extracts from the interviews, video-recordings and learner notebooks for each teacher are woven together to generate a composite picture of the teacher's preferred style of teaching and the teacher's use of the textbook, *Mfa7* LAB. These three data sets were used to validate inferences drawn about teachers' preferred pedagogic style and style employed in using *Mfa7* LAB.

3. Analysis of learner notebooks

For each teacher, I read through one notebook to establish the mathematics recorded there and the date on which the entry was recorded. I then checked through the other notebooks to confirm dates and entries and to fill in missing entries so that I could establish a composite picture of the mathematics dealt with by the teacher with dates and sequences of mathematical topics and sub-topics. This provided insight into similarities and differences in the teaching of measurement amongst the teachers and provided evidence of the extent of the teacher's use of *Mfa7* LAB. In contrast to Collins (2001), I was not interested in the differences between the notebooks of a particular teacher, unless these differences pointed to a particular practice of the teacher.

I also examined the notebooks for evidence of learners' recordings of notes and worked examples during class time, homework and whether evaluation of learners' productions was evident. I checked whether the teacher or the learners evaluated learner productions and the nature of the evaluation – whether it was simply marked, signed without marking, or whether mathematical errors were highlighted to learners. In addition, I established whether corrections were done and whether teachers or learners marked these. My interest in evaluation here was not to mark out whether learners had acquired mathematical knowledge, but rather to gain insight on teachers' methods of evaluation.

3.4 Contextual information

In this section I describe the context of the study. I provide a description of the schools of the teachers involved in my study, a profile of the teachers and the learners in their classrooms.

3.4.1 Description of the schools

All the schools involved in my research study are situated in former African townships on the Cape Flats. Three of the schools are situated in Khayelitsha and one school is situated in Phillipi. All the schools are located in built up areas with formal housing except for School M, a fairly new school located in the middle of an 'informal settlement'. School S, although in a more established area, is situated very close to an informal settlement from where most of the learners are drawn. All the schools are ex -DET schools and have an exclusively African enrolment. All the schools have brick buildings except for School Hp that has classrooms made from prefabricated materials.

Table 3.2 below summarises important features of the four schools: the location of the school, the number of pupils on the school roll, the number of learners, the number of teaching staff, the size of the class involved in the research project and the number of Grade 7 classes at the school. The information was constructed from the school questionnaires completed by the principals of the schools and from observations when I visited these schools.

Table 3.2: Information on project schools

	School	Location	Roll	Number of teaching staff[5]	Size of grade 7 research class	Number of grade 7 classes
Mr. Mafilika	M	Informal settlement area	1114	26	51	2
Mr. Faku	S	Formal settlement	1033	26	41	4
Mrs Nkosi	Hp	Formal settlement	570	14	59	2
Mrs Tyandela	H	Formal settlement	838	22	42	3

Although School S, School Hp and School H are located in fairly built up areas, the majority of the learners enrolled at the school come from the surrounding informal settlements. Table 3.3 below summarises the physical profile of the schools.

Table 3.3 Physical profile of project schools

	School	No of class-rooms	Offices	Hall	Library	Special rooms e.g. computer lab or science labs
Mr. Mafilika	M	22	4	1	1	1 science lab
Mr. Faku	S	25	5	0	0	1 computer room
Mrs. Nkosi	Hp	11	3	0	0	0
Mrs. Tyandela	H	24	3	0	0	0

All the schools have sufficient classrooms to allocate to each teacher and the classrooms themselves can accommodate the number of learners in each class. It is significant that only School M, the most recently built school, has a library.

3.4.2 Profile of teachers

In this section I describe the teachers involved in the research project. All the teachers in my sample have Xhosa as their first language. Two of the teachers are male and two are female. This gender balance is purely coincidental since the teachers were selected because they taught measurement in the observed lesson. The table below summarises information about these teachers, their highest level of formal education, number of years of teaching experience, grade levels they have taught, their past and present involvement in INSET. Table 3.4 outlines the profiles of teachers involved in my study. The information contained in Table 3.4 was constructed from the teacher questionnaires completed by the teachers. Teacher's involvement in INSET at the time of the research project was obtained from the interviews with teachers.

Table 3.4: Teacher profiles

	Level of formal education	Teaching experience	Grades taught	Past involvement in inset training	involvement INSET in 2000
Mr. Mafilika	M+3	10 years	7	MEP TSP PSP Departmental courses	SAILLI
Mr. Faku	M+3	11 years	4 to 7	PSP	None
Mrs. Nkosi	M+3	5 years	6 and 7[6]	PSP TSP	None
Mrs. Tyandela	M+5 B. Ed degree	14 years	5-7	MEP PSP TIP Departmental courses	READ

All the teachers besides Mrs Tyandela have matric plus a three-year teaching qualification. Mrs Tyandela is the only teacher with a postgraduate qualification. All the teachers are experienced teachers and have taught for some time except for Mrs Nkosi who taught grade 7 mathematics for the first time in 2000. All teachers have been involved in INSET in the past. Except for Mr Mafilika, none of the teachers were involved in mathematics INSET in 2000. Mrs Tyandela participated in an INSET project focusing on reading in 2000.

3.4.4 Profile of learners

In this section I describe the learners involved in the research project. Table 3.5 below provides a profile of these learners. The information in this table is based on teachers' responses about their learners in the teacher questionnaires.

[5] This includes principal, deputy and heads of department.
[6] Mrs Nkosi taught mathematics at grade 7 for the first time in 2000.

Table 3.5 Learner profiles

	School	Language of learners	Home back ground of learners
Mr. Mafilika	M	Exclusively Xhosa	Most learners are poverty stricken. Most of learners' parents did not receive more than primary schooling. Some come from homes without electricity Some live in homes without running water. Most have health or nutritional problems.
Mr. Faku	S	Exclusively Xhosa	Most learners are poverty stricken. Most of learners' parents did not receive more than primary schooling. Most come from homes without electricity Some live in homes without running water. Most have health or nutritional problems
Mrs. Nkosi	Hp	Majority of learners are Sotho speaking Minority of learners are Xhosa speaking	Most learners are poverty stricken. Most of learners' parents did not receive more than primary schooling. Most come from homes without electricity Some live in homes without running water. Some have health or nutritional problems.
Mrs. Tyandela	H	Exclusively Xhosa	Most learners are poverty stricken. Most of learners' parents did not receive more than primary schooling. Most come from homes without electricity Most live in homes without running water. Most have health or nutritional problems.

Table 3.5 indicates that learners at three of the schools are exclusively Xhosa speaking while the majority of learners at School Hp are Sotho speaking. The language of the learners is of crucial importance to this study since the textbook, *Mfa7* LAB is written in English. The learners at the four schools appear to come from similar home backgrounds.

3.5 Conclusion

The previous chapter positioned this study within a particular analytic framework while the present chapter has described the research design of the study, the data collected and instruments used and the context of the study.

In the next three chapters, I present the analysis of the *Mfa7* pedagogic texts and the analysis of the teacher's use of *Mfa7* LAB in the classroom.

Chapter 4

An analysis of the textbook: *Maths for all*

4.1 Introduction

The central focus of this chapter is the analysis of a textbook chapter and the accompanying teachers' guide as texts within the activity of school mathematics. The empirical focus of this analysis is Chapter 4, 'Measurement' in the *Maths for all* (*Mfa*) Grade 7 Learner's Activity Book (*Mfa7.4* LAB) and the accompanying chapter in the Teacher's Resource Book (*Mfa7.4* TRB). These texts are contained in Appendix 4.1 and 4.2 respectively. In addition, the notes 'To the learner' (see Appendix 4.3) and 'To the teacher' (see Appendix 4.4) in the LAB will be used to support inferences made about the textbook series.

The analysis of the aforementioned texts seeks to partially answer the research question: *What is the impact of Mfa7 LAB on Grade 7 mathematics teachers' classrooms?* As discussed in Chapter 1, the main research question generates a sub-question which the analysis of *Mfa7*.4 LAB and *Mfa7.4* TRB seeks to address. This sub-question can be stated as follows: W*hat is the nature of pedagogy privileged in the* textbook *Mfa7 LAB and associated teacher's guide?* In order to address this question, a number of questions, which frame the analysis, are outlined below:

- What mode of teaching and learning mathematics does *Mfa7* LAB privilege?
- How does the textbook construct learners, teachers and mathematics?
- How does the textbook make mathematical knowledge, in particular around the topic of measurement, available to learners and teachers? In other words, to what extent are teachers and learners given access to the recognition and realisation rules for the topic of measurement?
- To what extent does the textbook make the privileged pedagogy (the identities of learners and teachers, the relationship between them and privileged mode of learning and teaching mathematics) available to teachers and learners? In other words, to what extent are teachers and learners given access to the recognition and realisation rules of the privileged pedagogy?

The focus of the analysis of *Mfa7.4* LAB and TRB attempts to establish the extent to which the pedagogic text makes the recognition and realisation rules of mathematics and pedagogy available to learners and teachers. In other words, the analysis seeks to ascertain how the textbook positions teachers and learners as potential acquirers and whether the textbook apprentices learners into mathematics and teachers into its privileged form of teaching mathematics. In the discussion that follows I examine the texts as pedagogic texts for learners and teachers concurrently to avoid repetition.

The chapter is set out in the following way. Firstly, I discuss the general structure of *Mfa7* LAB, followed by a discussion of Chapter 4, 'Measurement' as a chapter within the textbook, *Mfa7* LAB and the associated chapter in *Mfa7* TRB. Finally, I discuss the analysis of the text which focuses on the construction of mathematics (the content and ideal pedagogy), the ideal learner, ideal teacher and ideal classroom in the text.

4.2 Maths for all textbook series

In this section, I broadly describe the structure of *Mfa7* LAB and the general structure of a chapter in *Mfa7* LAB. I then examine Chapter 4, 'Measurement' as a particular chapter in the textbook.

4.2.1 General Structure of Maths for all Grade 7 Learner's Activity Book

This section is concerned with a description of the key features of the textbook series, *Maths for all* and the function of these features in the textbook as a whole. The features described below are generic to all chapters in the textbook.

The textbook consists of chapters on different mathematical topics, projects and investigations. Each chapter in the textbook has the following features:

- an introduction which acquaints the reader with the contents of the chapter.
- a list of the intended outcomes for the chapter.
- a number of sections within the chapter. Each section in the chapter consists of activities (intended to introduce learners to new mathematical ideas) and exercises (intended for practice of mathematical concepts), described in more detail below.

- bullet points which come at the end of each activity. These bullet points summarise the mathematical concepts covered in the activities.
- a section called 'Meeting the outcomes' intended for learners to check whether they have achieved the learning outcomes for the chapter.

In the note 'To the teacher' in *Mfa7*.4 LAB, the role of the activities, bullet points and exercises are explained:

> It is expected that concepts and skills development takes place by working through these activities. The activities are designed to encourage learners to draw on familiar experiences and prior knowledge, to explore new ideas, to reflect on their own learning and to share ideas through writing, drawing, making and talking. We would recommend that class time be taken up with working through the activities and that learners work co-operatively on these as far as possible.
>
> Bulleted points at the end of each activity draw out the essential mathematical concepts and skills that are expected to be understood and achieved after working through the activity. These points should arise from whole class discussion but are in included in the book for learners' later reference. (*Mfa7* LAB: ix)
>
> The exercises are designed to consolidate the concepts and skills developed through the activities. As such, they can be used both for practice and assessment purposes. (*Mfa7* LAB: ix)

The extracts above privilege a particular way of learning mathematics. Mathematics is to be acquired by learners through exploration and working cooperatively with other learners. Learners are portrayed as active participants in the learning process as opposed to passive receivers of information transmitted by the teacher. The textbook implies that the teacher should not explicitly transmit mathematical knowledge to learners but rather that the 'mathematical concepts and skills [...] should arise from whole class discussion' (*Mfa7* LAB: ix). To a certain extent, therefore, learners are to become their own teachers. The social ordering of the classroom is relaxed to encourage learning through learner-learner interaction and discussion. This represents a weakening of framing but this, as Davis (2000) argues, represents an apparent rather than actual weakening of framing relations between learners and teachers[1].

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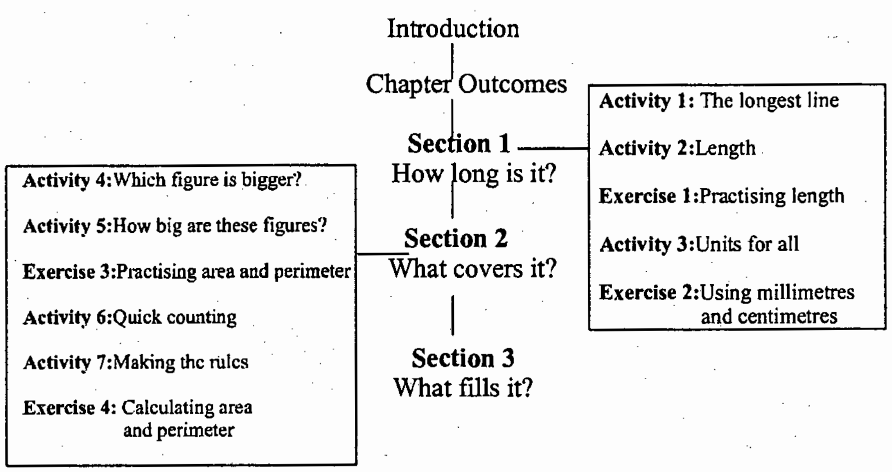
[1] 'Often pedagogies that claim to be "progressive" – irrespective of their political referents (liberalism, socialism, populism) – apparently relax framing so that the pedagogy is more "participatory", but on closer examination we find that the proponents of such pedagogies enforce *even stricter framing in the form of more detailed and precise rules for social relations and interactions ....'* (Davis, 2000: 12 – italics in the original)

Thus the statements in the extracts from 'To the teacher' have the appearance of factual description, but must be considered as instructions as well, since they delineate the behaviour of learners and teachers and therefore relay aspects of the social ordering of the classroom. The note 'To the Teacher' therefore positions *Mfa7* LAB as a pedagogic text for teachers.

4.2.2 The Measurement chapter

The Measurement chapter (See Appendix 4.1) constitutes one of the topics in *Mfa7* LAB and consists of sub-topics: length of lines, perimeter and area of two-dimensional shapes, volume and surface area of three-dimensional objects. I will focus only on the first two sections because these are the sections of the chapter that the teachers involved in the research project were asked to teach. Figure 4.1 shows the different components of *Mfa7*.4 LAB that I was interested in for my research.

Figure 4.1: Structure of *Mfa7.4* LAB



In Section 1, Activities 1, 2 and 3 develop the concepts of length and standardised units of length. Activity 1 involves the comparison of three roads represented as lines. In Activity 2, learners are provided with a line segment as a unit of length to measure these roads and in Activity 3, learners design a ruler with a unique unit of length to explore the notion of standardised units.

Figure 4.1 also shows the different components of Section 2 that deals with the measurement of two-dimensional space. In this section, four activities are used to develop the concepts of the measurement of two-dimensional shapes. The first two activities,

Activities 4 and 5 develop the concept of perimeter and area as two measurements of two-dimensional shapes. Activities 6 and 7 focus on developing the formulas for the perimeter and area of rectangles.

4.2.3 Broad features of the Teacher's Resource Book

In the TRB, the links between the textbook *Mfa7* LAB and C2005 in general are discussed. Each chapter of the TRB corresponds to a chapter in the LAB. Each chapter of the TRB contains a discussion on specific outcomes from the learning area MLMMS (Mathematical Literacy, Mathematics and Mathematical Sciences), as well as specific outcomes from other learning areas, the prior knowledge and skills learners require for the chapter, and links between the chapter from the LAB and the rest of the LAB. The chapter also contains detailed discussions on the activities. Here, suggestions of classroom arrangements, questions for discussions, and possible pitfalls are highlighted. Answers to activity tasks are generally not provided. Possible solution methods are provided for Activity 4 of Chapter 4 (Measurement) and some answers for tasks in Activity 5 are provided. Answers to exercise questions are also provided in the TRB.

The section above discusses key features of any chapter of *Mfa7* LAB, the broad structure of the Measurement chapter and broad features of the associated chapter in *Mfa7* TRB. In the next section, I present the analysis of *Mfa7.4* LAB and TRB.

4.3 Analysis of the pedagogic text

In this section, I analyse activities from *Mfa7.4* LAB and accompanying notes in the TRB to examine the mathematical knowledge made available in the textbook and its privileged mode of teaching and learning mathematics. The focus will be on the activities and bullet points since the textbook claims that is through the activities that mathematical knowledge is acquired. Activities 1 and 2 are discussed in detail to establish how the transmission and acquisition of mathematical knowledge is to be achieved. In this discussion, I mark out the construction of the *ideal learner*, *ideal teacher* and *ideal classroom* in the text, which is addressed in more detail in the sections that follow. I then show the extent to which the form of transmission and acquisition is manifested in the other activities.

4.3.1 Analysis of Activity 1

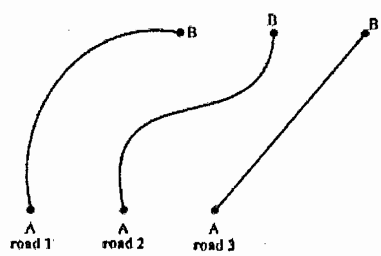
Plate 4.1: Activity 1, *Mfa7* LAB: 66

Activity 1 The longest line

Use any apparatus such as a pencil, ruler, tracing paper, scissors, string or a pair of compasses to answer the questions below.

Two towns can be represented by two points, A and B. Two curved roads and one straight road join them, as shown:

1. Which one of the three roads is the longest? Which road is the shortest?
2. How did you work out which road is longest or shortest? Which apparatus did you use?



3. Can you say how much longer or how much shorter the roads are compared to each other? Explain your answer.
4. In class, compare the different methods used to measure the length of the roads and discuss them.

In Activity 1, the task is to measure the length of three roads depicted as lines using the suggested physical resources such as string and tracing paper. The resources indicated in the LAB suggest particular methods of measuring lines. In an actual classroom, learners could use a variety of strategies to measure the lines. They could for example use string to compare the lines; or use a compass to mark off segments of the line and count the number of segments; or they could trace the line and use a ruler to mark off segments and count the number of segments. This suggests that there are many methods of measuring lines. However, a particular method for comparing the length of lines is not made explicit in the LAB or in the TRB. Teachers are given the following advice regarding Activity 1:

> Give the learners time to come up with the best possible strategies for finding the longest and shortest paths. Encourage creativity in thinking about strategies and discussion amongst learners. (*Mfa7.4* TRB: 34)

So not only does the textbook not provide a solution method but the teacher is also advised against explicitly transmitting the method for comparing the length of lines to learners. Instead, teachers are advised to encourage learners' engagement in practical exploration to discover the method. The only assistance teachers are advised to give to learners is the provision of sufficient time to do the task. In addition, the teacher is advised to 'encourage creativity' and to ensure that discussion takes place (*Mfa7.4* TRB: 34). Here, the textbook constructs the teacher as the facilitator and organisor of the pedagogic space and constructs the learner as autonomous, creative and capable of creating mathematical knowledge. The textbook assumes that learners will discover the method themselves through the use of the physical resources and through discussion with other learners.

The textbook claims that the bullet points at the end of the activity summarise the 'important mathematical concepts and skills' (*Mfa7.4* LAB: vi). For Activity 1 the bullet points are as follows:

- We hope you came up with different ways of measuring these roads.
- You can compare your methods to the one we suggest in the next activity.

(*Mfa7.4* LAB: 66)

In the above extract, the bullet points do not summarise any mathematical knowledge and do not provide method(s) for measuring lines. Instead learners are referred to Activity 2 where a particular method for measuring the lines is revealed. This demonstrates a significant strategy used in the book, namely to defer the explicit statement of mathematical knowledge to later points in the textbook. This is a pedagogic strategy employed as part of developing an inductive approach to learning mathematics. By deferring the mathematical knowledge, learners are encouraged to 'discover' mathematical knowledge before it is explicitly transmitted to them.

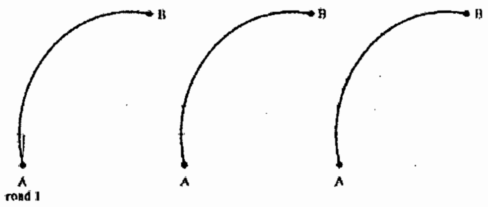
I now focus on an analysis of Activity 2 (*Mfa7.4* LAB: 67) to elaborate on the discussion of how mathematical knowledge and mathematics teaching is made available to learners and teachers respectively in the textbook.

4.3.2 Analysis of Activity 2

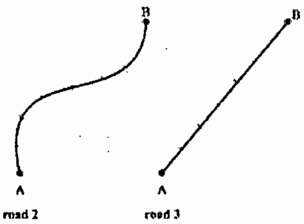
Plate 4.2: Activity 2, *Mfa7* LAB: 67

Activity 2 Measuring length

1. Draw a short, straight *line segment* on a page: —
2. Copy road 1 from Activity 1 onto lunch wrap or tracing paper.
3. Place the traced road 1 onto your line segment so that the endpoints of the two lines meet.
4. Mark points on the traced road as shown below:



5. Now trace road 2 and road 3 from Activity 1, and use your line segment to mark points along them as well.



a) Can you work out now which of the three roads is longest and which one is shortest?
b) Explain how you worked out your answer this time.
c) How much longer is the longest road than the shortest road?
d) Compare your answers in class and discuss any differences.
e) Would a longer or a shorter line segment be better to measure with? Discuss this with a friend.

In Activity 2, learners are asked to measure the three lines from Activity 1. This time however they are provided with a line segment which they need to use as a unit of measurement. Here, in contrast to Activity 1 where any method of measuring lines is acceptable, a particular method, the use of a line segment, is introduced to learners.

In Activity 1, learners were encouraged to devise several methods of measuring lines. While it is possible to determine the longest or shortest line with different measuring methods, it is not always possible to quantify the difference in length of the lines by using these informal measuring strategies. The bullet points following Activity 2 state that lengths can be compared by using a unit of length but do not refer to the limitations of the other informal measurement strategies such as the use of string. In addition, learners were asked in Activity 1, 'Can you say how much longer or how much shorter the roads are compared to each other?' (*Mfa7.4* LAB: 66). It appears that the intention of this question is to focus learners' attention on the limitations of methods such as using string to measure lines, but this intention is not made explicit in *Mfa7.4* LAB or TRB. This suggests that learners are expected to realise the limitations of informal measuring methods implicitly in Activity 2 by answering the question: 'How much longer is the longest road than the shortest road?' (*Mfa7.4* LAB: 67) or have it explained by the teacher.

The above discussion raises a number of important points. Firstly, the textbook uses the 'activity' for the exploration of mathematics. This in contrast to 'traditional' textbooks which use worked examples to explicitly present mathematical knowledge to learners. Worked examples are deemed by 'progressive' education to emphasise procedural knowledge since learners are shown step-by-step solutions which could potentially lead to teachers teaching particular methods and learners memorising particular solution strategies. The absence of worked examples from *Mfa7.4* LAB suggests that the textbook backgrounds procedural knowledge.

Secondly, it highlights the semantic dependence of Activity 1 on Activity 2. Activity 1, performed in isolation of Activity 2, is reduced to a simple comparison of lines. Without the connection with Activity 2, the mathematical complexity of Activity 1 is diminished. Since the knowledge about measuring lines is achieved by working through both activities, the textbook establishes a semantic link between Activity 1 and 2. However, this semantic link is not made explicit in *Mfa7.4* LAB or *Mfa7.4* TRB.

Thirdly, the discussion points to the use of sequencing as a pedagogic strategy within the textbook. Activities and questions are sequenced to move from open-ended tasks to more focused tasks. In this way learners are encouraged to explore and experiment before being directed towards the mathematical knowledge to be acquired. Thus the sequencing of activities and questions play a central role in the way which mathematical knowledge is made available to learners in the textbook. The textbook assumes that teachers and learners would work sequentially through a particular chapter. Teachers and learners are not made aware of the integral role played by sequencing in the development of mathematics in *Mfa7* LAB. Selective use of an activity de-linked from its associated semantic unit potentially reduces the mathematical complexity of the activity. The integral role played by sequencing in *Mfa7* LAB is indicative of the strong framing over sequencing in the textbook.

Fourthly, bullet points are also used as a pedagogic strategy in the textbook. Bullet points are used to defer the explicit statement of mathematical knowledge. In this way, the textbook moves from 'exploration' to explicit transmission. This cycle is repeated in the textbook and in this way, the bullet points support the inductive transmission and acquisition of mathematics and effects mathematical closure. Docs Lender

The bullet points following Activity 1 do not provide any solution methods to tasks set in the activity. In Activity 2 learners are directed to a particular method of measuring lines and finally the mathematical knowledge of measuring lines is explicitly stated in the bullet points at the end of Activity 2. Mathematical knowledge is therefore made explicit at the end of the semantic unit comprising of Activity 1 and 2. Hence, the recognition and realisation rules of mathematics are only made available to learners in the bullet points at the end of Activity 1 and 2 as follows:

- In this activity you measure the lengths of the roads by using a small straight line segment as a unit of measurement. We call this line segment a *unit of length*.
- The length of each road is found by adding up the units of length that fit on it.
- The longer the road, the more units of length fit on it.
- By using a unit of length, you are able to say how much longer or how much shorter the roads are compared to each other.
- The smaller (or shorter) the units of length, the greater the number of them that will make up the full length of a road. The smaller (or shorter) the units of length, the more accurately you can measure.

(*Mfa7* LAB: 68- italics in the original)

The bullet points above summarise the intended learning outcomes for Activities 1 and 2. These two activities give learners the opportunity to explore measuring of lines before being presented with a specific method of measuring lines. In this way, the bullet points explicitly state the mathematical knowledge that learners were meant to acquire from the activities and therefore serve as a pedagogic strategy to provide closure to the exploratory activities.

Mfa7 LAB explicitly makes teachers and learners aware of the importance of the bullet points in the notes, 'To the teacher' and 'To the learner' and the TRB actively encourages teachers to stimulate discussion in the classroom:

> The line segment shown for marking off equal segments on the curves is only a suggested unit of measuring. The greater the variety of lengths chosen, the better the comparison and discussion will be later. (*Mfa7.4* TRB: 34)

The above extract suggests that the teacher should set up the activity to ensure discussion and comparison in the classroom and in this way mathematical knowledge will be made available to learners. For example, learners can only realise that the unit of length affects the measurement of a line by comparing their answers with other learners who have used different line segments as units of length. Alternatively, the teacher could explicitly inform learners that the unit of length affects the measurement of a line. However, explicit teaching is not encouraged in the textbook. So learning is constructed as a social activity where learners acquire knowledge through group or whole class discussions initiated by the teacher. The textbook therefore relies on the teacher to make the mathematical knowledge contained within the activity explicit through discussion in the classroom.

4.3.3 Analysis of activities 3 - 7

Activities 3-7 are not discussed in the same detail as Activity 1 and 2 above to avoid repetition. In Table 4.1 below, I have summarised the contents of activities 1-7. Table 4.1 shows a description of each activity, resources used, additional information provided, the mathematical knowledge to be explored in each activity and the mathematical knowledge provided in the bullet points. In the column 4, 'the mathematical knowledge to be explored by learners' is stated in the form of questions which the activity seeks to address. Each question in column 4 has been numbered. Column 5 summarises the mathematical knowledge made explicit in the bullet points. These summary points have also been numbered. The numbering in the two columns serves the purpose of showing when learners explore a particular mathematical concept and when this mathematical knowledge is made explicit in the textbook. In Table 4.1 the task, 'How do we measure lines?' is numbered 1 in column 4 and the knowledge that 'lines are measured using a unit of length' is also numbered 1 in column 5. This indicates that the exploration of line measurement takes place in Activity 1 but the method of measuring lines is only made explicit in the bullet points after Activity 2.

Table 4.1: Description of Activities of *Mfa7.4* LAB

Description of activity	Resources used	Additional information provided in activity	Mathematical knowledge to be explored by learners	Mathematical knowledge summarised in bullet points
Activity 1 Three roads represented as lines that have to be measured using a variety of resources such as string and tracing paper.	Physical apparatus Class discussion		1. How do we measure lines? 2. How do we compare the lengths of lines?	Not mentioned in bullet points. Learner referred to Activity 2
Activity 2 Measurement of the same roads using a line segment as non-standard unit of measurement.	Tracing paper Class and peer discussion	Line segment provided to measure lines	1. How do we measure lines? 2. How do we compare the lengths of lines? 3. How does the unit of length affect the measurement of a line?	1. Lines are measured using a unit of length. 2. Comparison of length is possible by the number of units of length. 3. The size of the unit of length affects the measurement of a line.
Activity 3 Design a ruler with unique unit of measurement	Paper ruler Class and peer discussion		4. Why do we need standardised units of measurement	4.1 Standard units are necessary so that everyone gets the same measurement for a particular line. 4.2. Conversions from centimetres to millimetres and from metres to centimetres are provided.
Activity 4 Comparing the sizes of two-dimensional shapes using a variety of resources such as tracing paper	Physical apparatus Class discussion		5. How do we measure two-dimensional shapes?	Not mentioned in bullet points. Learner referred to Activity 5
Activity 5 Comparing the sizes of two-dimensional shapes using grids	Grids Class discussion	Grids provided to measure shapes	5. How do we measure two-dimensional shapes?	5. Perimeter and area is defined as two ways of measuring two-dimensional shapes
Activity 6 Calculate perimeter and area of the rectangles tiled with squared centimetres units.	Square centimetre tiles Peer discussion		6. Is there a short method for calculating the area and perimeter of a rectangle?	Learner referred to Activity 7
Activity 7 Calculate perimeter and area of the rectangles.	None	Learners are directed to look at a relationship between length, breadth and perimeter and length, breadth and area.	6. Is there a short method for calculating the area and perimeter of a rectangle?	6. Formulas for perimeter and area of a rectangle are provided

Because of space constraints, it is not possible for me to make available fully the scope of the analysis of the textbook and the basis upon which claims about it are made. The remainder of the analysis, that of Activities 3-7 is contained in Appendix 4.3.

4.3.4 Summary of the analysis of the pedagogic text

The discussion of Activities 1 and 2 here and of Activities 3-7 in Appendix 4.5 suggests that in *Mfa7.4* LAB, mathematical knowledge should be acquired and transmitted inductively through a series of 'explorations' and explicit transmissions. The textbook employs a number of pedagogic strategies to achieve an inductive approach to the teaching and learning of mathematics. The textbook uses the 'activity' for exploring mathematics, linked activities, summaries in the form of bullet points to defer the explicit statement of mathematical knowledge, and careful sequencing of activities and bullet points. In addition, the absence of worked examples from *Mfa7.4* LAB suggests that the textbook backgrounds the acquisition of procedural knowledge.

As discussed in Chapter 2, the transmission and acquisition of school mathematics exhibits high discursive saturation. As such, school mathematics content can be more or less fully realisable in language and a mathematics textbook can potentially make the principles of mathematics explicit within language to achieve apprenticeship into mathematics. The above analysis however, suggests that mathematical knowledge in *Mfa7.4* LAB is embedded in the activities of the textbook and that learners apprenticeship into mathematics is dependent on the teacher who is required to make mathematical knowledge explicit through classroom discussion.

Furthermore, as discussed in Chapter 2, the transmission and acquisition of the privileged pedagogy of the textbook is a hybrid of discursive and tacit practices and as such cannot be entirely realised in language. The privileged pedagogy, that is how to teach mathematics, cannot be completely communicated via the textbook. It needs to be demonstrated in the site of practice, the school classroom.

In the discussion above, I have alluded to the identity and expected behaviour of the ideal learner and teacher in the detailed discussion of Activities 1 and 2. The textbook constructs learners as autonomous, creative and capable of creating mathematical knowledge. It assumes that learners will discover the solution methods themselves through the physical resources suggested in the activities or through discussion with other learners. The ideal teacher is constructed as the facilitator in the classroom, who is implicitly advised against explicit teaching and explicitly encouraged to facilitate and ensure discussion amongst learners. In this way, learning is constructed as a social rather than an individual activity. The discussion below focuses on the extent to which the construction of the ideal learner and teacher is maintained in the rest of *Mfa7.4* LAB and a discussion on the construction of the ideal classroom in the textbook follows.

4.4 Construction of the ideal learner

In this section, the construction of the ideal learner in the textbook is elaborated. Firstly, I examine the construction of the learner as a 'creator' of mathematical knowledge. This is followed by a discussion of the construction of the learner in terms of ability and finally by the construction of the learner as an autonomous learner.

4.4.1 Construction of the learner as 'creator' of mathematical knowledge

In section 4.3.1, I illustrated in the discussion of Activity 1 that the learner is constructed in the textbook as autonomous, creative and capable of creating mathematical knowledge. This construction of the learner is supported by the instruction to the learner in the note 'To the learner':

> You are meant to **DO** these activities in class, preferably by working in pairs or groups. The activities are designed to encourage you to draw on familiar experiences and knowledge, to explore new ideas, to reflect on your own learning and to share ideas through writing, drawing and talking. (*Mfa7.4* LAB: vi, emphasis in original)

The above extract, besides alluding to the privileged forms of classroom social interaction, also constructs the learner as capable of using 'familiar experience and knowledge' as a resource for discovering 'new' mathematical knowledge.

None of the activities provide solution methods to the learners. Model answers or worked examples are also not provided in the LAB. The textbook therefore assumes that learners will discover the method themselves, either through the use of the physical resources suggested or provided in the textbook, or through discussion with other learners. Physical resources and social interaction therefore constitute repertoires for the production of the method that is made explicit through discussion in class.

4.4.2 Constructing the learner in terms of ability

None of the questions in the exercises and activities are graded in terms of levels of difficulty. The lack of graded exercises is alluded to in the note 'To the teacher':

> The exercises are not very long so as to enable **all** learners to work through **all** the questions. (*Mfa7.4* LAB: ix, my emphasis)

All learners are assumed to be capable of doing all the activities and exercises in the textbook. In other words learners are constructed as having equal potential. This equality of learners resonates with the current socio-political view of society. With the ushering in of the new political dispensation in South Africa, the rhetoric of an ideal society in which hierarchies are diminished exists within the current political and economic discourse. This vision of providing equal opportunities to all citizens has been recontextualized into identity of the learner and the pedagogy in C2005 and the *Maths for all* textbook series. The title of this textbook emphasises the idea that everyone can do mathematics and should have access to mathematics. The textbook therefore privileges a particular social order that underpins the pedagogic discourse instantiated by this textbook.

In the extract from *Mfa7.4* TRB teachers are provided with guidance on how to deal with Activity 1 (*Mfa7.4* LAB: 66):

> Give the learners **time** to come up with the best possible strategies for finding the longest and shortest paths. Encourage creativity in thinking about strategies and discussion amongst learners. (*Mfa7.4* TRB: 34, my emphasis)

The TRB advises teachers to give learners time to develop the best measuring strategies. This suggests that given sufficient time all learners have the ability to produce the required mathematical knowledge. Learners therefore appear to be in control of pacing which represents a weakening of framing. In addition, the learner is constructed as undifferentiated in terms of ability.

4.4.3 Constructing the learner as an autonomous learner

In this section, I examine how the textbook constructs the learner as autonomous. The introduction of the chapter is followed by a list of learning outcomes for the chapter (*Mfa7.4* LAB: 65), which outline the knowledge and skills that a learner should achieve by working through the chapter. 'SOs 1, 4, 5 & 9' are stated in the box containing the outcomes. These refer to the Specific Outcomes for the Learning Area MLMMS in the Curriculum 2005 policy documents. The reference to the specific outcomes and the form in which the intended learning outcomes of the chapter are stated affiliates the textbook with Curriculum 2005 and Outcomes-Based Education.

The outcome statements are addressed to the learner: 'After working through this chapter, you should be able to:' (*Mfa7* LAB: 65). The use of the pronoun 'you' positions the learner as a potential apprentice to the discourse. The learner is informed that he/she will become proficient in this topic of mathematics by working through the chapter. The purpose of the outcome statements is revealed in the note 'To the learner':

> The last section in each chapter is called "Meeting the outcomes". If you can answer all the questions in this section then you have achieved all of the chapter outcomes. Where you have problems you should give yourself more practice by going back to work done earlier in the chapter. Ask your teacher for more examples. (*Mfa7.4* LAB: vii)

The textbook places the responsibility for learning on the learner who is charged with monitoring his/her own learning. However, the learner requires the teacher to provide the answers to the exercise questions since these answers are not provided in the *Mfa7.4* LAB. Although the learner is constructed as autonomous in the textbook, the learner is dependent on the teacher for the correct answers to assess whether s/he has achieved the learning outcomes.

4.4.4 Summary of the construction of the learner

In summary, the textbook constructs an ideal learner who is capable of working independently of the teacher. The ideal learner is capable of discovering mathematical knowledge by drawing on familiar experiences and knowledge and by working co-operatively and engaging in discussion with other learners. In addition the ideal learner is capable of reflecting and monitoring his/her own learning and is constructed as undifferentiated in terms of ability.

The textbook is explicit about the characteristics of the ideal learner and the kind of behaviour expected from the ideal learner. However, as discussed before, the pedagogy of the textbook which encompasses the identity and behaviour of the learner, is largely tacit and therefore cannot be acquired fully from the textbook. Learners can only learn how to behave as expected by a textbook in a classroom which models such behaviour. In the next section I discuss the construction of the ideal teacher in the textbook.

4.5 Construction of the ideal teacher

The teacher is directly addressed in the note 'To the teacher' in *Mfa7.4* LAB and is directly referred to three times in the note 'to the learner' and 12 times indirectly in *Mfa7.4* LAB.

In the direct address, teachers are provided with information about features of the book and the connections between the book and C2005. The teacher is also told to encourage 'learners to focus on these outcomes and to measure their progress against them' (*Mfa7* LAB: viii). This implies that learners should monitor their own progress and operate autonomously in the mathematics classroom and that the teacher's role is to manage this process.

The teacher is also provided with pedagogic guidelines:

> We would recommend that class time be taken up with working through the activities and that learners work co-operatively on these as far as possible. [...] We do not expect learners to spend large amount of class time on practice work. [...] These points should arise from whole class discussion of the activities ...(*Mfa7.4* LAB: ix)

While these pedagogic guidelines detail precise rules for social relations and interaction in the classroom, they also construct the teacher as the manager of class time ensuring co-operative work amongst learners probably in small groups or pairs, whole class discussions and time for practice work.

The three direct references to the teacher in the note 'To the learner' also construct the teacher as the classroom manager. The first reference informs the learner that 'you and your teacher should set clear goals and check whether you are meeting them' (*Mfa7* LAB: vi). The second reference directs the learner to ask the teacher to discuss the bullet points in the classroom. The third reference directs learners to ask the teacher for practice exercises if required. These references construct learners as responsible for their own learning and possessing the authority to request assistance from the teacher. Furthermore, these references construct the teacher as a resource for learners for additional tasks or class discussions and as assisting learners with managing their learning.

The indirect references in *Mfa7.4* LAB are implicit in the form of the instructions in the activity and exercises: 'Compare your answer in class.' (*Mfa7.4* LAB: 67, 69), 'Compare and discuss your answers in class' (*Mfa7.4* LAB: 68), 'Discuss this with a friend' (*Mfa7.4* LAB: 67, 69), or 'Compare the different methods used' (*Mfa7.4* LAB: 66, 69, 70). Here the teacher is constructed as the manager of the classroom and as the facilitator of group and class discussions in the classroom.

In summary, the textbook constructs the teacher as the organisor of the pedagogic space and encourages the teacher to defer explicit teaching of mathematical knowledge. Once more, like the identity and expected behaviour of the ideal learner, the characteristics of the ideal teacher can only be acquired fully through demonstration in the site of practice and cannot be completely communicated via the textbook.

4.6 Construction of the ideal classroom

In this section I discuss the construction of the ideal classroom in the textbook. Firstly, I examine the nature of the social relations in the classroom i.e. the relations between learners and teachers and between learners. Secondly, I discuss the forms of communication privileged in the ideal classroom.

4.6.1 Construction of social relations in the ideal classroom

The textbook refers to forms of social interaction between learners and between learners and teachers. The textbook constructs the following explicit forms of social interaction between the learner and a friend (another learner in the same class); and between the learner and the class. The learner is required to interact ('discuss', 'explain', 'ask a friend to work out a problem') four times in the *Mfa7.4* LAB and interact with the class ('compare and discuss in class') eight times in the *Mfa7.4* LAB. The teacher is also explicitly instructed in the TRB to arrange social interaction between learners: 'Encourage learners to work in pairs for the first two activities in this section' (*Mfa7.4* TRB: 33). The interaction between teachers and learners is implied by the instructions in the LAB which indicate that class discussions should take place and explicitly stated in the TRB when the teacher is instructed to ask questions to stimulate discussions in class (*Mfa7.4* TRB: 33, 34, 37, 38).

In addition, the textbook uses pronouns as a resource for establishing social relations in the class. For example in the introduction to *Mfa7.4*:

> In this chapter we ask questions about size. We look at the size of lines, of flat figures and of solids and explore different ways of measuring them. We will get to know what numbers we need before we can measure objects. (*Mfa7.4* LAB: 65)

The use of the pronoun 'we' affiliates the reader (learner) with the textbook authors and positions the learner as an apprentice working with people already located in the discourse of school mathematics. The learner is to behave like mathematicians who, together with the authors will embark on exploring the measurement of lines and shapes. At the outset of the chapter, therefore the textbook indexes the kind of behaviour expected from learners. The use of the pronoun 'we' can also be regarded as signalling an emphasis on the communalising of learning and points to the horizontal relationships between learners. Learner-learner interaction is a central form of social interaction in the learning process.

The pronoun 'you' is used to address the learner directly. For example, in reference to the outcome statements at the beginning of the chapter 'After working through this chapter, you should be able to' (*Mfa7.4* LAB: 65), the learner is positioned as an apprentice who has to work through the activities to access the discourse. Here the learner is positioned in a subordinate position to the author. This relationship, extrapolated to the actual classroom is analogous to the vertical relationship between the learner and the teacher, where the learner is the apprentice and the teacher the expert.

The textbook constructs the nature of the relationships between learners and between learners and teachers as discussed in section 4.4.2 and section 4.4.1 respectively. The textbook constructs learners as undifferentiated in terms of ability thus establishing equal relationships between learners. The hierarchical relationship between the teacher and learners is reduced, resulting in an ideal classroom in which individuals are constructed as 'equals' in the textbook.

Thus the ideal classroom privileges social interaction in the forms described above. These forms of interaction privileged in the textbook mirrors the notion of 'ubuntu' currently in vogue in South African society that advocates the working together of the nation to achieve political success. Similarly by working together in the classroom learners can achieve academic success. Thus the textbook privileges the communalising of knowledge acquisition.

4.6.2 Forms of communication in the ideal classroom

In section 4.3.1, I discussed Activity 1 which encourages learners to find different ways of measuring roads. The bullet points (*Mfa7.4* LAB: 66) following the activity do not provide a particular method of measuring the roads. In fact, the first bullet point suggests that the textbook celebrates differences of opinion in the classroom. Learners are encouraged to devise different ways of measuring roads which are not judged as correct or incorrect.

> Have the class decide which pair produced the best strategy: they need to consider both the accuracy and simplicity of the strategy. (*Mfa7.4* TRB: 34)

The textbook suggests that there isn't only one correct strategy but that there is a 'best' strategy. No basis is provided for judging the 'best' strategy other than a reference to 'accuracy' and 'simplicity'. The decision of the 'best' strategy is not predicated on any mathematical knowledge but on the opinion of the learners. In addition, the TRB awards the authority for deciding on the 'best' solution to the learners. Here the teacher as the prime curriculum authority is reduced since learners are depicted as having the capacity to adjudicate in contrast to 'traditional' pedagogy where the teacher is portrayed as the mathematical expert in the classroom. This celebration of opinion and the weakening of the framing between teacher and learners reflects the social order of the pedagogic discourse of *Mfa7.4* LAB which mirrors the current democratic social order in South Africa where all citizens are considered equal and have rights to their own opinion.

Here it appears that the textbook implicitly constructs a classroom in which freedom of expression is encouraged. The extract from the TRB's discussion of Activity 2 confirms this.

> Question 5 may present an initial stumbling block to some learners. They need to think carefully about it, then answer the question according to their own understanding as developed in the activity. (*Mfa7.4* TRB: 34)

Also in the note 'To the teacher', the teacher is encouraged to allow learners 'to share their ideas through writing, drawing, making and talking' (*Mfa7* LAB: ix). Thus constructing a classroom in which learners are able to express themselves freely.

In summary then, the textbook constructs a classroom in which individuals and ideas are considered equal and in which learners are free to interact with each other and free to express themselves. The ideal classroom is held to be a microcosm of South African society which illustrates how the discourse of the social order of the country has been recontextualized into the social order of the classroom.

4.7 Conclusion

Mfa7 LAB constitutes a pedagogic text for learners and read intertextually with *Mfa7* TRB as pedagogic texts for teachers. The textbook is concerned with the transmission and acquisition of mathematics and a privileged pedagogy which includes the identity of teachers and learners, the relationship between them and the privileged mode of learning and teaching mathematics. In this chapter, I have discussed strategies used by *Mfa7* LAB to induct learners and teachers into the activity of school mathematics. The privileged pedagogy embodied in *Mfa7* LAB is summarised below in Table 4.2.

Table 4.2 Privileged pedagogy of *Mfa7* LAB

Ideal learner	A learner who: • is capable of working independently of the teacher. • discovers mathematical knowledge through exploration. • reflects and monitors own learning. • works co-operatively with other learners. • engages in discussion with other learners. • is undifferentiated in terms of ability.
Ideal teacher	A facilitator who: • manages class time • facilitates discussion in groups and the whole class • teaches inductively as opposed to explicit teaching • manages learners' mathematical progress • provides resources for learners
Ideal classroom	A classroom in which: • learner-learner interaction is privileged over learner–teacher interactions • learners are considered 'equals' i.e. weak framing between learners • teacher-learner relationship is weakened i.e. framing is weak. • discussion in groups and the whole class is encouraged • freedom of expression is encouraged

Privileged mode of teaching and learning mathematics.	Mathematics is learnt and taught: • without solution strategies or worked examples provided. • through exploration. • inductively. • actively and practically. • through discussion with other learners. • by backgrounding procedures. • by developing the underlying principles in mathematics.

I have also discussed the pedagogic strategies employed by the textbook to achieve an inductive approach to the learning and teaching of mathematics. Seven activities are used to inductively develop mathematical knowledge of length, perimeter and area. The pedagogic strategies, used in the textbook, can be summarised as follows. Firstly, the textbook uses the 'activity' as the textual space for the exploration of mathematics. Secondly, activities are linked to form semantic units within the textbook. Thirdly, bullet points are used to defer the explicit statement of mathematical knowledge to the end of a semantic unit. Fourthly, careful sequencing (of activities, tasks within activities and bullet points) support an inductive approach to learning and teaching mathematics. Hence, the framing values over sequencing and selection are strong while the framing value over pacing is weakened. The semantic dependence of these activities and the importance of the sequencing of activities in the development of mathematics are not made explicit in *Mfa7.4* LAB or the TRB. In addition, mathematics knowledge is only explicitly stated in the bullet points at the end of a semantic unit.

As discussed in Chapter 2, the transmission and acquisition of school mathematics exhibits high discursive saturation. As such, school mathematics content can be more or less fully realisable in language and a mathematics textbook can potentially make the principles of mathematics explicit within language to achieve apprenticeship into mathematics. In *Mfa7* LAB however, I have argued that mathematics is made available only partially to teachers and learners because it is not always explicitly stated in the textbook. As such, *Mfa7.4* LAB makes mathematical knowledge partially available to acquirers and consequently positions acquirers as *novices*. The textbook relies on the teacher to make the mathematical knowledge embedded in the activities of the textbook explicit through classroom discussion. Apprenticeship into mathematics can therefore not be achieved solely through the use of the textbook.

Aspects of the privileged pedagogy are stated in notes 'To the learner' and 'To the teacher' in *Mfa7* LAB and in the accompanying notes in the TRB and in the (implicit and explicit) instructions to learners and teachers in the textbook. However, the transmission of a privileged pedagogy exhibits low discursive saturation (DS-) and therefore cannot be transmitted entirely linguistically. Aspects of the privileged pedagogy can only be acquired through modelling in practice. The recognition and realisation rules of mathematics and the privileged pedagogy are therefore only partially made available in *Mfa7* LAB and TRB to learners and teachers.

So, although the textbook constructs learners as capable of working independently of the teacher, the learner's apprenticeship into school mathematics can only be achieved if the teacher possesses certain knowledge. The teacher needs to have the necessary mathematical knowledge and the necessary skills to teach mathematics inductively. The textbook relies on the teacher's knowledge and skills to effect closure between the exploratory tasks in the textbook and the mathematical knowledge learners need to acquire to be apprenticed into the activity of school mathematics. The textbook cannot achieve apprenticeship on its own as a pedagogic text for learners and teachers. The textbook addresses learners and teachers as if they are apprentices to the activity of school mathematics. However, the ideal teacher and learner in *Mfa7* LAB are positioned as *novices* because they are provided with partial access to the activity of school mathematics.

On the basis of this analysis I predict that the effective use of textbook in the classroom depends on the teacher's knowledge of mathematics and skill in using a learner-centred inductive pedagogy. In addition, I also predict that the selective use of this textbook, *Mfa7* LAB will potentially result in a reduction of the mathematical complexity of the tasks contained in the textbook or a fragmentation of the mathematics presented. On the other hand, I predict that a close following of the sequence of the textbook could potentially result in extremely slow pacing of mathematical knowledge.

In the next two chapters, Chapter 5 and 6, I examine the use of the textbook *Mfa7* LAB in grade 7 mathematics teachers' classrooms. These two chapters focus on the potential use of the textbook as a pedagogic text or as a resource in the constitution of the teacher's classroom practice.

Chapter 5

Analysis of how teachers use the Maths for all textbook: Part 1

5.1 Introduction

In this chapter and the next, I move into the empirical setting and analyse the classroom practices of four teachers. The video-recorded lessons, the learner notebooks and two interviews of each teacher will be used as data to construct the pedagogic practices of these teachers. The analysis, presented in this chapter and the next, explores the recontextualization of the textbook when incorporated into a teacher's classroom practice. In addition, the analysis seeks to establish the relationship between the teachers' classroom practice and the practices of the textbook. In other words, the analysis attempts to ascertain whether teachers affiliate with or objectify the practices of the textbook. The sub-questions, which this part of the study seeks to address, are outlined below.

- What is the nature of the teacher's classroom practice?
- How do teachers, through their classroom practice, construct learners and mathematics?
- How does the teacher's preferred teaching mode compare with the mode of teaching privileged in the textbook?
- How does teacher's pedagogy compare with pedagogy privileged in the textbook?
- How do teachers use *Mfa* in their classrooms? How do teachers use *Mfa* to design their lessons? How do teachers use *Mfa* with their learners?
- How do the practices privileged in the textbook become transformed (recontextualized) when incorporated into a teacher's classroom practice?

A description of the context of the schools, some general characteristics of the learners and a brief professional history of each teacher was described in Chapter 3. The analytical tools employed in this chapter and the next were described in Chapter 2. This chapter focuses on the classroom practices of two teachers, Mrs. Tyandela and Mrs. Nkosi while Chapter 6 focuses on the classroom practices of Mr. Faku and Mr. Mafilika[1].

[1] These are pseudonyms and not the real names of teachers.

For each teacher, I first examine the teacher's preferred mode of teaching and compare it to the mode privileged by *Mfa7* LAB. I then construct the teacher's classroom practice from the video-recorded lesson and the learner notebooks. This analysis at the same time attempts to describe the teacher's construction of learners and mathematics and compares the teacher's construction with the textbook's construction of learners and mathematics. In addition, I examine how the teacher used *Mfa7* LAB to design her lessons for the teaching of measurement. The teachers' use of textbooks with their learners is discussed in Chapter 6.

5.2 Mrs. *Tyandela's classroom practice*

5.2.1 Preferred mode of teaching

In this section I describe the teacher's preferred mode of teaching and compare it to the mode privileged by *Mfa7* LAB. In the second interview Mrs. Tyandela described how she used a sheet of paper folded into fractional parts to teach learners about comparison of fractions with different denominators:

> Then after they have practised that, I ask them, let's colour one quarter and then colour maybe three eighths. Which one is bigger, a quarter or three eighths? Then they can now see from the papers that they made that which one is bigger than the other one. Right after I think, now they are ready, I just go for an exercise for classwork. (Extract from Interview 2)

In the above extract, the teacher described her typical teaching practice as involving practical activities that she used to assist learners to develop mathematical knowledge inductively. Her preferred teaching mode is reflected in her views expressed about *Mfa7* LAB in the interview:

> T: But *Maths for all* that is different. Because you find that for a period you spend the time doing practical work coming up with discussion from different learners.
> I: So would you recommend *Maths for all* to other teachers?
> T: Yes. [...] I will tell them about the promotion of practical work and finding for yourself what is it you must do. (Extracts from Interview 1)

[T = teacher and I = interviewer]

From the extracts[1] above, it appears that the teacher aligns herself with and develops her teaching mode in ways similar to that promoted in *Mfa7* LAB. She advocates learning mathematics through practical activities and discussion which gives learners the opportunity to actively explore and discover mathematical knowledge themselves before being explicitly taught by the teacher. The teacher's preferred teaching mode appears to be comparable to the inductive, exploratory pedagogy embodied in *Mfa7* LAB. It therefore appears that Mrs. Tyandela affiliates with the practices of the textbook and that she has used *Mfa7* LAB as a pedagogic text. The analysis below provides additional evidence for this claim. Furthermore, the analysis which follows attempts to determine whether Mrs. Tyandela demonstrates the recognition and realization rules of the practices of the textbook in her classroom practice. In the next section, the teacher's classroom practice as displayed in the video-recorded lesson is examined.

5.2.2 Classroom practice constructed from video-recorded lesson

In the video-recorded lesson, the teacher started the lesson by handing out a photocopy of page 69 of the *Mfa7* LAB. The use of photocopies from the textbook will be discussed in Chapter 6[2]. The teacher reviewed previous work done on measurement, questioning learners about Activity 1 and 2[3] (*Mfa7.4* LAB: 66-67) and questions 1 and 2[4] from Exercise 1 (*Mfa7.4* LAB: 68-69). In this review of work which learners had completed previously, the teacher revisited the different ways of measuring a line and used tracing paper or string rather than a ruler to measure this. She also questioned learners to re-establish that the length of a line is dependent on the unit of length. She then dealt with

[1] The teacher's preferred mode of teaching is also reflected in this extract from interview 1.
'I like your style [of the *Mfa7* LAB – SJ] because it points out how do to certain things and after that you tell them [the learners – SJ] this is how it takes place. I like that idea find out for yourself and then you are told. [...] What I tried to do in my classroom is for everybody to take part and to see what is taking place. That's what I like about the book [*Mfa7* LAB] itself. **It promoted my way of thinking.** (Extracts from Interview 1 – my emphasis)

[2] The teachers were given a classroom set of textbooks but learners were not using the book in class.

[3] Activity 1 involves comparing the length of three roads with different apparatus, such as string, tracing paper etc. Activity 2 also involves comparing the length of the same roads as in Activity 1, but learners are given a particular unit of measurement, a given line segment. The activity requires learners to compare the lengths of the roads by marking off the given unit of measurement on the roads using tracing paper.

[4] Question 1 involves a triangle and rectangle made from string with equally spaced knots as the unit of measurement. Learners have to decide which shape is bigger. Question 2 focuses on the measurement of the length, breadth and thickness of a textbook using a matchstick.

question 3 and 4[6] of Exercise 1 (*Mfa7.4* LAB: 68). In question 3, the teacher demonstrated to learners how to measure the height of a desk with a pencil, all the learners measured the height of their desk individually, the teacher then recorded some of the measurements on the board and proceeded to question them about why the measurements were different. She moved on to question 4, questioning learners about why the length of a matchstick depicted in the textbook has different measurements. Both questions 3 and 4 dealt with the same concept of length covered in the review of previous work, namely that the unit of length affects the measurement of a line. A detailed outline of the lesson is displayed in Appendix 5.1 which shows the different tasks in the lesson, the resources used, the amount of time spent on each task and the teachers' and learners' actions within each task.

The teacher spent 16 minutes (28,1%) of the lesson on the review of previous work[7], 22 minutes (38,6%) on question 3 and 19 minutes (33,3%) on question 4, which she did not complete in the lesson. The entire lesson focused on the same concept of measurement established in the review of previous work, namely that the size of the unit of length affects the measurement of a line. The lesson thus progressed at an extremely slow pace and all the learners were expected to work together. The teacher therefore did not differentiate learners in terms of ability and the framing over pacing in the lesson was strong and slow.

The teacher used a combination of instructions, explanations, demonstrations and question-and-answer discussions. No learner-initiated discussion occurred in the lesson. The following extracts show how the teacher used her questions and learners' responses to deal with the concept that the measurement of a line is dependent on the unit of length used. The extract below shows the teacher questioning the learners after they measured their desk with a pencil.

> T: Why we are measuring the same desk, the length of the desk was the same as this one? Do you know this?
> C: Yes.

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[6] Question 3 involves measuring a desk with a pencil and comparing the answer with others in the class and Question 4 is based on the measurement of the same matchstick using two rulers (Thelma's and Zuleigha's) that are different to each other. The learners have to explain why you get different measurements of the same object using Thelma's ruler and using Zuleigha's ruler.

[7] In response to a question in the second interview about what changes the teacher would make to her lesson, she responded: 'I will change my introduction (referring to the review of previous work), it was too long. I was trying to show the people of UCT what I have done.'

T: Tell me why is pencil A having 3 and ½ pencil lengths [i.e. the desk measured with pencil A is 3 and a half pencil lengths – SJ] and pencil B seven and half, seven and pencil C eleven? Why are? Why especially these ones? Why is this one and this one so different? Why?
L: Because pencil A is bigger than pencil C.
T: And so what? And so what? She says we know that this pencil is longer than this one. Right and so what? If it is longer, why should we have different measurements? Joy
L: This one takes a big space.
T: The long one takes a bigger space. Is she right?
C: Yes
(extract from video-recorded lesson)

[T = teacher, L = learner and C = class]

The above extract shows the ways in which the teacher used questions involving reasoning and explanation to establish the underlying ideas in measurement, that is, the idea that the length of a line is dependent on the unit of length. In this way the teacher elicited mathematical knowledge from learners, using an inductive approach to the learning of mathematics.

The teacher worked with the whole class for 47 minutes (82,4%) of the lesson and learners worked individually for 10 minutes (17,6%) of the lesson. This individual work included 4 minutes on a practical activity of measuring the height of a desk with a pencil and 6 minutes on writing a sentence about the effect of the unit of measurement on length after the class worked through question 3 of Exercise 1 (*Mfa7.4* LAB: 68).

The teacher chose to work together with the whole class to answer questions 3 and 4 of Exercise 1 (*Mfa7.4* LAB: 68) rather than giving learners the opportunity of working individually or in groups to grapple with mathematics independently of her. Learners were expected to learn by answering the teacher's questions and listening to other learners' responses. The teacher tended to privilege learners communicating with her over learners communicating with each other in the learning process. In this sense, the lesson exhibited strong framing relations.

In the first interview the teacher revealed that she thought that *Mfa7* LAB promoted individual work and not group work but that she used group work sometimes in her teaching and in the second interview the teacher explained her reasons for using groupwork.

I: You said that you used group-work. Is that a way that you often work?
T: No, I don't use it often. Sometimes, you'll find that there are some problems where they are getting difficulties, they can't do individually, so if you can group them others will understand quicker.
I: Um, so when, when will you use groupwork? When you think individuals will learn better in a group?
T: Um, Sometimes the book [Maths for all-SJ] says speak with your partner, okay, speak with your group. So when the book ask this, we do that. We do ask them to work in groups. You'll find that they are discussing a lot, coming up with different answers.
(extract from Interview 2)

Although the teacher did not use groupwork in the video-recorded lesson, the interview indicates that she tended to use a combination of different modes of teaching. These included practical activities followed by practice exercises done individually or in groups when required, and whole class question-and-answer discussions. Although the teacher had a varied repertoire of teaching modes, whole class question-and-answer discussions appeared to be the dominant mode in which the teacher inductively elicited mathematical knowledge from learners. From the above discussion, Mrs. Tyandela shows a facility with the practices of the textbook. She demonstrates the recognition and realisation rules of the textbook's practices in that she is able to both describe the practices of the textbook and successfully implement the textbook practices. The teacher's learner notebooks are now examined as further evidence of her classroom practice.

5.2.3 Classroom practice constructed from the learner notebooks

For the measurement section, learners recorded answers to the activities and exercises in their notebooks and pasted photocopied tasks from *Mfa7.4* LAB into their notebooks. The entries in my sample of notebooks of this teacher's class were very similar to each other. All the notebooks contained answers to exactly the same tasks in the same order and photocopied pages of the *Mfa7.4* LAB were pasted in the books in the same places.

In the video-recorded lesson, the teacher gave learners specific instructions about where to paste the photocopies and where to write in their notebooks. This indicates that the teacher had strong control over the entries in learners' notebooks. In addition, the teacher marked all the learners' work in the notebooks. Learners redid work, marked as incorrect by the teacher under the heading 'corrections'. The teacher marked these as well. The corrected versions of the answers to activities or exercises were the same in different learners' notebooks, which suggests that the learners copy down the corrections from the board.

The extract from the video, the position of the entries and photocopied pages in the notebook, and the teacher's extensive marking of learners work suggests that the teacher exercised strong control over the recording in learners' notebooks. This indicates strong framing relations within this classroom.

There is no evidence of worked examples in the notebooks. For example, it is not clear from the notebooks how the teacher dealt with conversion of units of measurement. It appeared from the answers to question 3[7] from Exercise 2 (*Mfa7.4* LAB: 70) that learners were not taught a specific method for converting from centimetres to millimetres before answering the exercise. Learners did not appear to know how to convert from cm to mm in fraction or decimal form. They seemed to think that the rule was to 'add a zero'. Variations to converting 2,5 cm to mm in the learners' notebooks were as follows: 20,5 mm, 250 mm or 20,50 mm and to converting 5¼ cm to mm is 50¼ mm or 52 mm. These answers suggest that learners were not initially taught a method for conversion of units and were required to discover a method on their own. This mirrors the pedagogy of *Mfa7.4* LAB that assumes that learners first attempt to construct a method for conversion of measurements on their own before the teacher explicitly explains a method. The notebooks therefore appear consistent with a teaching mode which favours teaching and learning mathematics inductively.

5.2.4 Use of textbooks in the teaching of measurement

In this section I contextualise and position the video-recorded lesson in the teacher's sequence of lessons on measurement and examine how the teacher used *Mfa7.4* LAB to design her lessons on measurement. In the extract from interview below, the teacher explained how she used *Mfa7.4* LAB:

> I tried to follow the same sequence [as *Mfa7.4* LAB – SJ] because for me it was useless to start at the beginning and then to choose the other one [activity – SJ] because it [*Mfa7.4* LAB – SJ] has been written in a sequence. That is what I like about it.
> (Extracts from Interview 1)

The teacher indicated in the above extract that she followed the sequence of *Mfa7.4* LAB, a claim which is supported by the entries in the learner notebooks contained in Appendix

[7] This question involves converting measurements from centimetre to millimetre.

5.2. Appendix 5.2 illustrates that except for the first lesson, her lessons on measurement were based entirely on *Mfa7.4* LAB. Table 5.1 summarises the tasks used by the teacher from *Mfa7* LAB in the teaching of measurement. The first column describes each activity in *Mfa7.4* LAB. The second column describes the mathematical knowledge learners are meant to explore in each activity. The third column describes the mathematical knowledge summarised in the bullet points in *Mfa7.4* LAB and the fourth column describes the mathematical knowledge made explicit by the teacher. The first three columns are extracts from Table 4.1 in Chapter 4 of this thesis. The last column in the table, the mathematical knowledge made explicit by the teacher, was constructed from the learner notebooks, the video-recorded lesson and the interviews.

Table 5.1: Mrs. Tyandela's design of the teaching of measurement

Description of activity in *Mfa7.4* LAB	Mathematical knowledge to be explored by learners in *Mfa7.4* LAB	Mathematical knowledge summarised in bullet points in *Mfa7.4* LAB	Mathematical knowledge made explicit by the teacher
Activity 1 Three roads represented as lines that have to be measured using a variety of resources such as string and tracing paper.	1. How do we measure lines? 2. How do we compare the lengths of lines?	Not mentioned in bullet points. Learner referred to Activity 2	1. Emphasises different ways of measurement e.g. using string etc. other than using a ruler[8].
Activity 2 Measurement of the same roads using a line segment as non-standard unit of measurement.	1. How do we measure lines? 2. How do we compare the lengths of lines? 3. How does the unit of length affect the measurement of a line?	1. Lines are measured using a unit of length. 2. Comparison of length is possible with a unit of length. 3. The size of the unit of length affects the measurement of a line.	1. Lines are measured using a unit of length. 2. Does not deal with this in video and not reflected in notebooks. 3. The size of the unit of length affects the measurement of a line[9].
Exercise 1 (Practice exercise based on above activities.)			All questions done in notebook.
Activity 3 Design a ruler with unique unit of measurement.	4. Why do we need standardised units of measurement?	4.1 The need for standard units of length. 4.2. Conversion of standard units of length provided. In bullet points	4. 1 Not clear from notebooks[10]. 4.2. Conversion of standard unit length covered in exercises.
Exercise 2 (Practice exercise based on above activities.)			All questions done in notebook.
Activity 4 Comparing the sizes of two-dimensional shapes using a variety of resources such as tracing paper.	5. How do we measure two-dimensional shapes?	Not mentioned in bullet points. Learner referred to Activity 5.	5. Different ways of measurement e.g. using string[11].
Activity 5 Comparing the sizes of two-dimensional shapes using grids.	5. How do we measure two-dimensional shapes?	5. Perimeter and area is defined as two ways of measuring two-dimensional shapes	5. Different ways of measurement e.g. counting triangles or using string.
Exercise 3 (Practice exercise based on above activities.)			Selected questions.
Activity 6 Calculate perimeter and area of the rectangles tiled with squared centimetres units.	6. Is there a short method for calculating the area and perimeter of a rectangle?	Learner referred to Activity 7	6.Applied area and perimeter formulas because learners derived area formula in Exercise 3 and knew perimeter formula from previous grade[12].
Activity 7 Calculate perimeter and area of the rectangles.	6. Is there a short method for calculating the area and perimeter of a rectangle?	6. Formulas for perimeter and area of a rectangle are provided	6.Applied area and perimeter formulas.
Exercise 4 (Practice exercise based on above activities.)			Selected questions.

Table 5.1 illustrates that the teacher largely followed the sequence of the topic of measurement as set out in the *Mfa7.4* LAB. For the section on length (Activity 1 to

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[8] The teacher concluded the question-and–answer discussion on question 1 of Exercise 1 by emphasising the measurement of lines using string etc. other than using a ruler as an important mathematical knowledge to be remembered.

[9] Teacher dealt with the effect of the unit of length in the video-recorded lesson.

[10] In the interview teacher emphasised that all the learner's measurements were correct because they were using their own unit of length and she could not say that they were wrong.

[11] This is evident in the learners' answers in the notebook.

[12] This is evident in the learners' answers in the notebook.

Exercise 2) the teacher dealt with all the activities and exercises. In the section on area, particularly after Activity 5, it appeared from the notebooks that the teacher departed from following *Mfa7.4* LAB as strictly as before and became much more selective. She selected particular questions from the remaining tasks in *Mfa7.4* LAB and she appeared to use Activity 6 and 7 as practice exercises for the application of area and perimeter formulas of rectangles. The teacher's practice here appears to be in contrast to the inductive, exploratory approach of the *Mfa7.4* LAB where Activity 6 and 7 develops the formulas for area and perimeter of rectangles[13]. Apart from the teacher's use of Activity 6 and 7 as practice exercises, the teacher's design of the measurement topic is comparable to *Mfa7.4* LAB.

Table 5.1 compares the mathematics presented by the teacher with the mathematics presented in the *Mfa7* LAB. For example, the teacher, in contrast to the textbook, used Activity 1 to demonstrate that there are many ways besides using a ruler to measure lines. There is therefore a variation between the teacher's reading of the activity and the intention of *Mfa7.4* LAB. In addition, the teacher did not appear to make learners aware of the role of units of length and the limitations of informal measuring strategies. The video-recorded lesson and the interviews with the teacher suggest that for her the most important learning outcome for the section on length is the informal measurement strategies made available in *Mfa7.4* LAB[14].

The variation between the teacher's interpretation of the activity and the intention of the textbook I would argue is due to the way in which mathematical knowledge is embedded in the activities of *Mfa7* LAB (see Chapter 4 of this thesis). The teacher herself recognised that mathematics is not made explicit in *Mfa7* LAB and in *Mfa7* TRB as the extract from the interview shows:

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[13] The extract below suggests that the teacher did not need to use the tasks in *Mfa7.4* LAB to develop the formulas for area and perimeter of rectangles since the learners had acquired these previously.

> [T]he other part [Activity 6 and 7 – SJ] where you introduce the rules for area and perimeter, they [the learners – SJ] already knew them [area and perimeter – SJ] so much that they were bored. (Extract from Interview 1)

[14] For example, in the extract from the video where the teacher concluded the discussion on the exercise question in which a rectangle and triangle is formed by a knotted string:

> T: In other words, we can measure with a string. We can use which, which er which of them is bigger than the other even by using a string! Did we use a ruler for this exercise?
> C: No
> T: We didn't use a ruler. We didn't use a ruler on this exercise, which means that anything, **we can measure by using anything, anything**. (Extract from video, my emphasis)

> T: I don't like it [*Mfa7* TRB – SJ]. [...] I will recommend something like this Learners' Activity Book because this is challenging even for me because I have to first concentrate here how are the questions are asked but they (learners – SJ] are not told. I am not told how you will answer that question. I can prepare with that book [*Mfa7* LAB-SJ] but for going to the classroom giving learners exercises I have to look at this one [*Mfa7* TRB-SJ] because I can't teach learners or I can't go to learners [with – SJ] something that I don't even understand. I have to read the questions and what it says and what is expected of them. So I don't like it [*Mfa7* TRB – SJ] much. [...] I can't even see an example here. [...] Maybe this book takes for granted that we are teachers. So at least we know. Although we are teachers we need to know the exercises you know or examples. (Extract from Interview 1)

In the above extract the teacher criticizes the *Mfa7* TRB because it does not provide examples or answers to activity tasks. She indicates that she found the LAB challenging and that the TRB should provide answers to activities and examples. The teacher therefore approved of the inductive, exploratory approach of *Mfa7* LAB but advocates that teachers need access to the mathematics that is implicit in the activities and considers it important that teachers should be provided with solutions and worked examples to teach effectively. The learner notebooks indicate that Mrs. Tyandela affiliates with the textbook and uses the textbook as a curriculum guide for the teaching of measurement.

5.2.5 Summary

Mrs. Tyandela's classroom practice can be described as incorporating practical activities which give learners the opportunity to actively explore and discover mathematical knowledge themselves before being explicitly taught by the teacher, teacher-led question-and-answer discussions, demonstrations and explanations. In addition, she used question-and-answer discussions to elicit the principles underlying mathematical knowledge. Furthermore, she used *Mfa7* LAB exclusively for the teaching of measurement and followed the sequence of the textbook. In fact, she completed almost every task in the textbook resulting in a very slow teaching pace.

Table 5.2 summarises and compares the mathematics presented by Mrs. Tyandela with the mathematics intended by the textbook, which was established in chapter 4 of this thesis.

Table 5.2 Comparing mathematics presented by Mrs. Tyandela with Mfa7.4 LAB

	Mrs. Tyandela	*Mfa7.4* LAB
Mathematical knowledge to be acquired by learners	• Different ways of measurement e.g. using string etc. other than using a ruler. • Lines are measured using a unit of length. • Lengths can be compared with a unit of length. • The size of the unit of length affects the measurement of a line. • Applied area and perimeter formulas of a rectangle	• Lines are measured using a unit of length. • Lengths can be compared with a unit of length. • The size of the unit of length affects the measurement of a line • The need for standard units of measurement. • Derive formulas for perimeter and area

Table 5.2 illustrates that Mrs. Tyandela emphasises different ways of measurement as an important learning outcome of the measurement section and does not focus on the need for standard units of measurements. This suggests that she does not achieve all the learning outcomes set out by *Mfa7* LAB. This, I have argued, is a result of the partial embedding of mathematics knowledge in the text. Table 5.3 summarises the teacher's pedagogy and compares it to the pedagogy privileged within *Mfa7* LAB, which was established in chapter 4 of this thesis.

Table 5.3: Comparing Mrs. Tyandela's pedagogy with Mfa7.4 LAB

	Mrs. Tyandela	*Mfa7.4* LAB
Ideal learner	A learner who: • is not capable of working independently of the teacher • discovers mathematical knowledge • dependent on the teacher to monitor own learning • works mainly individually and co-operatively at times • engages in discussion with the teacher • undifferentiated in terms of ability	A learner who: • is capable of working independently of the teacher. • discovers mathematical knowledge through exploration. • reflects and monitors own learning • works co-operatively with other learners. • Engages in discussion with other learners • is undifferentiated in terms of ability
Ideal teacher	A teacher who: • uses an inductive teaching approach as opposed to explicit teaching • facilitates question-and-answer discussions mainly with the whole class • provides resources for learners	A facilitator who: • uses an inductive teaching approach as opposed to explicit teaching • facilitates discussion in groups and whole class • provides resources for learners manages class time
Ideal classroom	A classroom in which: • teacher-learner interaction privileged over learner-learner interaction • discussion take place in groups and whole class but mainly whole class • strong framing between teacher and learner	A classroom in which: • learner-learner interaction is privileged over learner–teacher interactions • discussion in groups and the whole class is encouraged • weak framing between teacher and learner.
Mathematics teaching and learning	Mathematics is learnt and taught: • without solution strategies or worked examples provided. • through exploration • actively and practically • inductively • through discussion with the teacher. • by backgrounding procedures • by developing the principles of mathematics	Mathematics is learnt and taught: • without solution strategies or worked examples provided. • Through exploration • Actively and practically • Inductively • Through discussion with other learners. • by backgrounding procedures • by developing the principles of mathematics

Table 5.3 illustrates that there is a close match between the features of the pedagogy of the teacher and those embodied in *Mfa7.4* LAB. The main difference is that there are stricter framing relations between learners and the teacher in Mrs. Tyandela's class than is suggested by the pedagogy in the textbook. As Mrs. Tyandela articulated earlier, she attributes her pedagogy to *Mfa7* LAB. She therefore identifies with the practices of the textbook. In addition, she understands the logic of the textbook and demonstrates that she is able to use the inductive, exploratory pedagogy of the textbook effectively. In the model of recontextualization, Mrs. Tyandela can be classified as an *affiliator* who demonstrates access to the recognition and realization rules of the practices of the textbook. She can therefore be described as an *apprentice* to the practices of the textbook. In the next section I focus on the classroom practices of Mrs. Nkosi.

*5.3.*Mrs. *Nkosi's classroom practice*

5.3.1 Preferred mode of teaching

In this section I describe the teacher's preferred mode of teaching and compare it to the mode privileged by *Mfa7* LAB. In the second interview the teacher explained how she typically teaches a mathematics lesson.

> Before I introduce the lesson, I ask them a few questions that will lead to the topic on that lesson, something that will make them clear whatever we going to do that day. And then from that point, so to make for them easier I usually do groupwork for those who don't understand and who those who grasp slower than others and then for exercises I like them to do individually to make sure that they do understand.
> (Extract from Interview 2)

and

> What I noticed with this textbook [*Mfa7* LAB – SJ], you'll find the activities is more difficult than the exercises, so in most activities I use groupwork and for the exercises I use self-individual work.
> (Extract from Interview 2)

From the extract above, it appears that the teacher, besides introducing the lesson by asking questions, gives the learners the opportunity to grapple with mathematics independently of her through the use of groupwork in which learners work co-operatively. The teacher's description of a typical lesson provides insight into how she uses the *Mfa7* LAB. The teacher recognises that *Mfa7* LAB uses an exploratory, inductive approach to teaching mathematics. However, her views about how a textbook ought to work differ from the inductive pedagogy of *Mfa7* LAB. In the interview she describes the problems with *Mfa7* LAB:

> Learners in maths need more practice to calculate, ja to solve problems [...] but also they [*Mfa7* LAB authors – SJ] must focus on the formula. [...] and also before they give the act...exercises, they must state the examples clearly because some of the learners they can't solve their problems, they need the example. They can't build their own formulas on how to solve that particular problems. They need the example first.
> (Extract from Interview 1)

and her reasons for preferring another mathematics textbook to *Mfa7* LAB:

> I think the English there is simple and there are more examples before the learners are given the exercise. First they state the examples and then follow the exercises.
> (Extract from Interview 1)

These two extracts above indicate the teacher's views of learning mathematics, that is, that learners learn best when provided with examples and then practice exercises. Her views of the textbook suggest that she prefers to teach mathematics deductively rather than inductively. However, Mrs. Nkosi acknowledged in the second interview that she did not have a scheme of work and that she used the textbook and advice from her principal as a guide to the mathematical content she needed to cover for grade 7. In the absence of curriculum support[15], Mrs. Nkosi used *Mfa7* LAB as a guide even though the textbook's pedagogy conflicted with her preferred pedagogy. *Mfa7* LAB therefore served, in part at least, as a pedagogic text for Mrs. Nkosi.

It appears then, in using *Mfa7* LAB she attempted to use the inductive, exploratory pedagogy of the textbook which differed from her preferred mode of teaching[16]. As I will show later, this created conflict for the teacher. So Mrs. Nkosi, like Mrs. Tyandela, attempted to use *Mfa7.4* LAB to teach mathematics inductively. The above discussion illustrates that Mrs. Nkosi had an ambivalent relationship with the textbook. Despite the tension between her preferred style and the textbook's style, she attempted to implement the practices of the textbook, as I will demonstrate below. She can therefore be characterised as an *affiliator*. The analysis below seeks to establish whether Mrs. Nkosi

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[15] C2005 provided teachers with very little guidance with respect to mathematical topics and sequencing of topics.
[16] The entries in the learner notebooks do not contain any worked examples, which suggest that the teacher did not use a deductive teaching mode she said she preferred.

demonstrates the recognition and realisation rules of the textbook's practices. I now examine Mrs. Nkosi's classroom practice constructed from the video-recorded lesson.

5.3.2 Classroom practice constructed from the video-recorded lesson

In the video-recorded lesson, the teacher started off the lesson with a series of instructions, explanations and questions before allocating tasks to be completed in groups. She introduced learners to the concept of area by asking them to rub the cover of their mathematics exercise book and informed them that the unit of measurement for area is the square centimetre. She then used the rectangles (divided into square centimetre units) in Activity 6 (*Mfa7.4* LAB: 75) to teach learners how to calculate the area of a rectangle. Learners were taken through a number of tasks before the teacher presented them with the formula for the area of a rectangle. Table 5.4 shows an outline of the different tasks in the lesson. A more detailed outline is contained in Appendix 5.3 which shows the sequence of the lesson, the time for each task and the actions of the teachers and learners.

Table 5.4 Outline of the tasks in Mrs. Nkosi's lesson

Tasks	Time
Defining area and units of measurement	6 min
Recognising shapes	3 min
Measuring blocks of rectangle 1	2 min
Counting rows rectangle 1	5 min
Counting blocks rectangle 1	1 min
Finding area of rectangle 1	4min
Defining length and breadth	4 min
Measuring length and breadth of rectangle 1	8 min
Stating rules for area	4 min
Rehearsing rules for area	3 min
Calculating area for rectangle 3 and 4	11 min

During the lesson, the teacher alternated between working with the whole class and allowing learners to work together in groups. As Appendix 5.3 shows, she spent about 30 minutes (58,8%) teaching the whole class and 21 minutes (41,2%) on group work. Although the teacher employed group work, the tasks outlined in Table 5.4 above could have been done individually since the tasks essentially involved counting and measuring. Whole class teaching dominated the lesson which proceeded very slowly. The framing over pacing was therefore strong and slow. In addition, learners were not given the opportunity to work at their own pace. The teacher thus constructed the learners as undifferentiated in terms of ability.

Appendix 5.3 illustrates that the teacher used a combination of exposition, instruction, explanation and questioning learners in the lesson in which very little learner-initiated discussion occurred. The instructions and expositions frequently involved repetition and restatements as the extract below from the beginning of the lesson shows:

> T: You rub the cover of your, of the closed exercise book. You rub over the cover of the closed exercise book. You must rub the cover of your maths exercise book. Rub with your hands the cover of the closed maths exercise book. Rub it with your hands, not with your fingers, with your hands. Rub it with your hands. Rub it with your hands. Rub it with your hands. Don't lay, rub! Remember you must rub your whole cover of your maths exercise book. You must rub your whole cover, not only one place. Rub the whole closed cover of your maths exercise book. I want to see everybody doing that.
> (Extract from video)

The above extract shows that the teacher repeated the instruction 'to rub the cover of their maths exercise book' 12 times to the learners. The teacher's use of repetition was a characteristic of the lesson on the whole where instructions and definitions were restated several times. The teacher appeared to use repetition both to clarify instructions and to rehearse the required mathematical knowledge so that learners were provided with several opportunities in the lesson to memorise the mathematical knowledge. Hence, the teacher constructed mathematics as a set of contents to be memorised and learners as those requiring repetition in order to learn mathematics. The teacher explained in the interview why she used repetition in the lesson:

> I noticed that some of them, they are confused, they didn't understand that is why I kept repeating the same thing.
> (Extract from Interview 2)

The teacher's reasons for the repetition is reiterated in her comments about *Mfa7* LAB in the first interview:

> I: So you believe it [*Mfa7* LAB-SJ] is more for people ...
> T: for active learners. The slower learners take time to understand. But ultimately they do understand but you have to do a lot of explanation.
> (Extract from Interview 1)

This extract suggests that the teacher positioned *Mfa7* LAB as a textbook for 'more able' learners. The teacher indicates that 'slower' learners require several explanations in order to understand the mathematics. She thus uses repetition with learners she considers to be 'slow' or 'less able'.

During the question-and-answer sessions in the lesson, the teacher posed mostly factual recall questions or questions, emphasising nomenclature such as the names of shapes, or questions involving definitions for length and breadth as the extract below from the lesson illustrates:

> T: Who can tell us the names of the shapes that we see on that page [*Mfa7.4* LAB: 75 – SJ]. Just tell the class the name of the shapes that you see on that page....Nomqubelo?
> L: inaudible
> T: We want the names of that shapes that you see on page 75.
> L: square
> T: Which one is the square? We have got numbers from 1 to 4.
> L: 2, number 2.
> T: He says number 2 is a square. Do we agree with him?
> C: Yes
> T: The other names of the shapes. Which one is a rectangle?
> (Extract from video)

In the extract above, the teacher asked learners to identify the shapes even though the text states that the shapes are rectangles. It is not clear whether the teacher did not read the preceding text properly or whether she assumed that the learners were unable to read the text themselves and she was therefore assessing whether they are able to recognise shapes. It is also unclear whether the learner identified the 'square centimetre blocks' in the rectangles as squares or whether he was referring to the rectangles as squares. The teacher however did not ask the learner to provide reasons for his answer and therefore the learner's response was not used as a pedagogic resource.

In my description of the lesson thus far, I have pointed to frequent repetition that served to assist learners to memorise mathematical facts. The lesson was dominated by whole class teaching and teacher-initiated discussion and the kinds of questions asked involved factual recall rather than reasoning. As an observer of the lesson, I found the lesson extremely difficult to follow and there appeared to be some ambiguity about what the teacher was attempting to convey in the lesson. My interpretation of this lesson and the reason I found it difficult to follow was because there was a tension between the inductive style of the book and the teacher's preferred deductive style. The teacher expected that the learners would 'discover' the formula in the lesson through the questions and tasks that she provided. However, the learners did not 'discover' the formula which gave rise to confusion in the lesson.

Throughout the lesson, the teacher repeatedly informed learners that there are 'rules for area' but did not immediately provide these rules. At no point in the lesson did the teacher explain how the different tasks (outlined in Table 5.4) were related to each other and how they were related to the 'rules for area'. She spent about 33 minutes of the lesson (64,7%) on these tasks before presenting learners with a procedure for calculating for area. The extract from the video illustrates the teacher's procedure for finding the area of a rectangle.

> T: Now, let us come to the rules of the area. First we must use the standard unit for area, that is the square centimetre and then when you want to find the area or the surface of the closed shape. What you must do, you measure the length and your breadth and then you must multiply that length and that breadth. Do you understand [Xhosa –SJ]. In order to get the area, you must multiply that length and that breadth, the measurement that we have found for the length and the measurement we have found for the breadth.
> (Extract from video)

The teacher thus attempted to use an inductive approach to finding the formula for the area of a rectangle. This inductive approach, however, conflicted with her preferred mode of deductive teaching which resulted in the segmentation of the task (finding the formula for the area of a rectangle) into sub-tasks with very little if any connections between them being made apparent to the learners. The overall effect was a fragmented, protracted lesson in which the learning of procedures was prioritised. From the above discussion, it appears that Mrs. Nkosi could not implement the textbook's practices successfully. In other words, she was not able to demonstrate the recognition and realization rules of the textbook's practices. As such, Mrs. Nkosi can be described as a teacher who attempted to affiliate with the textbook practices due to her circumstances but who was dependent on the practices of the textbook. In the next section, the learner notebooks from her class are examined as further evidence of her classroom practice.

5.3.3 Classroom practice constructed from learner notebooks

For the measurement section, learners recorded answers to the activities and exercises in their notebooks. By checking across all the notebooks, I established a composite picture of the tasks assigned by the teacher for the measurement section. I established that the measurement topic consisted of tasks assigned by the teacher on 10 different dates. A detailed description of these entries is contained in Appendix 5.4 and will be discussed in more detail in section 5.3.4. Of the six notebooks I examined, no individual notebook contained a full record of the tasks assigned by the teacher. The notebooks ranged from being 50% to 90% complete, where these percentages are calculated on the basis of whether the learner completed the tasks set by the teacher[17].

The teacher marked the answers to the activities and exercises with ticks and crosses which indicated whether the answers were correct or incorrect respectively. The teacher evaluated[18] or signed almost all the entries for measurement in all the learner notebooks except for three entries in two learners' books that were not marked. The teacher communicated with learners by writing comments such as 'incomplete' or 'Do corrections' in their notebooks. Learners appeared not to respond to these comments and failed to complete the work. Thus, even though the teacher regularly monitored learners' work, she appeared to defer the responsibility for the completion of work to the learner[19].

None of the notebooks represented a full record of the tasks assigned by the teacher, which raises questions about how the notebooks functioned in this class as a record of the teaching and learning of school mathematics[20]. In addition, the notebooks as records of teaching and learning are affected by the teacher's evaluation of learner productions. In the measurement section, all the learner notebooks contained mathematical errors that the teacher marked as correct. These ranged from two marking errors in a notebook to a notebook that contained seven mathematical errors marked as correct.

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[17] Missing and incomplete entries, including missing or incomplete corrections to tasks, could be due to learners' absence from class when those entries were recorded or learners not doing the work assigned to them by the teacher or a combination of these factors.

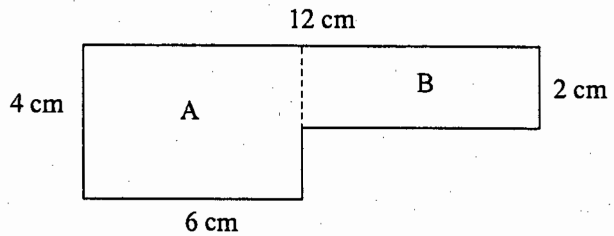
[18] By evaluation, I mean that the teacher marked the exercises done by learners with a tick if the answer is correct or cross if the answer is incorrect.

[19] Alternatively, the learners' failure to complete the work even after the teacher had pointed this out to the learner, could be interpreted as signs of the learners' disregard for the teacher's authority. The state of the notebooks described above can be read as potential indicators of a weakening of the framing relations in this class.

[20] Adler et al (2001: 79) deals with the same issue in their study on written texts in Gauteng schools. They found that due to classroom practices which did not encourage learners to engage with textbooks themselves, learners regarded their notebooks as the only record of the mathematics they were required to learn.

An example of a mathematical error marked as correct in all the learners' notebooks is shown in the extract from a learner's notebook below. The task in this example is to find the area of A and B.

A = L X B
= 12 cm X 2 cm
= $24\ cm^2$



[Extract from learner notebook]

It is difficult to assess whether the teacher genuinely does not know the answers or whether the mistakes in marking are due to an oversight on her part. The incomplete notebooks coupled with marking errors undermine the notebooks as a resource for learners to reconstruct the mathematics covered in class in preparation for tests and examinations, particularly after long time periods. This may seriously impede their access to the discourse of mathematics, thus producing learners as dependent.

The notebooks do not contain any worked examples. As with the notebooks in Mrs. Tyandela's class, the answers to the exercise questions involving conversion of units reflect that a specific method for converting from centimetres to millimetres appeared not to have been provided to learners before they attempted the exercise questions. Learners were required to discover a method for conversion of measurements on their own which mirrors the pedagogy of *Mfa7.4* LAB. The notebooks therefore confirm that the teacher attempted to teach mathematics inductively which differed from her preferred deductive pedagogy.

5.3.4 Use of textbooks in the teaching of measurement

In this section, the video-recorded lesson is contextualised and positioned within the teacher's sequence of lessons of measurement and I examine how the teacher used *Mfa7.4* LAB to design her lessons on measurement.

Table 5.5 illustrates that the teacher used *Mfa7* LAB exclusively in the teaching of measurement and that she used the textbook selectively. As I will go on to show, the teaching of measurement as reflected in the notebooks mirrored the fragmented video-recorded lesson of this teacher discussed earlier. Table 5.5 also shows the description of each activity in *Mfa7.4* LAB, the mathematical knowledge to be explored by learners, the mathematical knowledge summarised in the bullet points in *Mfa7.4* LAB and the mathematical knowledge made explicit by the teacher. The first three columns are extracts from Table 4.1 in Chapter 4 of this study. The last column in the table, the mathematical knowledge made explicit by the teacher was constructed from the learner notebooks, the video-recorded lesson and the interviews.

Table 5.5 Mrs. Nkosi's design of the measurement chapter

Description of activity from *Mfa7.4* LAB	Mathematical knowledge to be explored by learners in *Mfa7.4* LAB	Mathematical knowledge summarised in bullet points in *Mfa7.4* LAB	Mathematical knowledge made explicit by the teacher
SECTION 1: Length			
Activity 1 Three roads represented as lines that have to be measured using a variety of resources such as string and tracing paper.	1. How do we measure lines? 2. How do we compare the lengths of lines?	Not mentioned in bullet points. Learner referred to Activity 2	1. Emphasises different ways of measurement e.g. using string etc. other than using a ruler. 2. Compares lines using ruler measurement.
Activity 2 Measurement of the same roads using a line segment as non-standard unit of measurement.	1. How do we measure lines? 2. How do we compare the lengths of lines? 3. How does the unit of length affect the measurement of a line?	1. Lines are measured using a unit of length. 2. Comparison of length is possible with a unit of length. 3. The size of the unit of length affects the measurement of a line.	Incomplete in all the learners' notebooks in my sample and not marked by the teacher
Exercise 1 (Practice exercise based on above activities)			All questions done.
Activity 3 Design a ruler with unique unit of measurement	4. Why do we need standardised units of measurement	4.1 Standard units are necessary so that everyone gets the same measurement for a particular line. 4.2. Conversions from centimetres to millimetres and from metres to centimetres are provided.	Omitted by teacher.
Exercise 2 (Practice exercise based on above activities)			All questions done.
SECTION 2: Perimeter and area			
Activity 4 Comparing the sizes of two-dimensional shapes using a variety of resources such as tracing paper	5. How do we measure two-dimensional shapes?	Not mentioned in bullet points. Learner referred to Activity 5	5. Different ways of measurement e.g. using string. Only two learners record the answers to this activity in their notebooks.
Activity 5 Comparing the sizes of two-dimensional shapes using grids	5. How do we measure two-dimensional shapes?	5. Perimeter and area is defined as two ways of measuring Two-dimensional shapes	Omitted by teacher.
Exercise 3 (Practice exercise based on above activities)			Omitted.
Activity 6 Calculate perimeter and area of the rectangles tiled with squared centimetres units.	6. Is there a short method for calculating the area and perimeter of a rectangle?	Learner referred to Activity 7	6.Applied area and formula.
Activity 7 Calculate perimeter and area of the rectangles.	6. Is there a short method for calculating the area and perimeter of a rectangle?	6. Formulas for perimeter and area of a rectangle are provided	6.Applied area and perimeter formulas. Selected question 2 only
Exercise 4 (Practice exercise based on above activities)			Selected questions.

Table 5.5 shows that in the section on length, the teacher omitted essential developmental tasks, Activities 2 and 3 from *Mfa7.4* LAB. She directly proceeded to Exercise 1 and 2

which are intended as practice exercises to consolidate the concepts developed in the preceding Activities (1 and 2) and 3 respectively. This suggests that Mrs. Nkosi did not follow the logic of the inductive pedagogy of the textbook. She subordinated the textbook to her preferred pedagogy and as such fragmented the practices of the textbook.

In the next section on area and perimeter, the teacher dealt with Activity 4[21], omitted Activity 5 and Exercise 3 and used Activity 6 and 7 and Exercise 4 as practice exercises for the application of area and perimeter of rectangles. From Activity 6 onwards the teacher appeared to revert to her preferred pedagogic style, a deductive pedagogy which emphasised the learning of procedures. The video-recorded lesson provided insight into how the teacher taught the area of a rectangle and the notebooks reflect that the learners recorded 5 different ways of writing the formula for perimeter[22]. Even though the learners wrote down the formula for the perimeter in their calculations, they appeared to simply add up the lengths of the rectangle without actually substituting into the formula. For example, in one of the learner's notebooks the solution to question involving perimeter was recorded:

> Perimeter of a door P = (2 X L) + (2 X B)
> = 195 cm + 195 cm + 80 cm + 80 cm = 550 cm
> (Extract from Mrs. Nkosi's learner notebook)

Mrs. Nkosi, like Mrs. Tyandela, privileged the informal strategies of measuring lines as an important concept emerging from Activity 1. In contrast to Mrs. Tyandela however, Mrs. Nkosi did not complete Activity 2 and she skipped Activity 3. Activity 1 is therefore semantically separated from the rest of the activities in the section on length. Activity 1 is reduced from an activity which together with Activity 2, attempts to develop the concept that units of length are required to quantify the difference in the lengths of lines, to an activity in which different ways of measuring lines are stressed. The mathematical complexity of Activity 1 is therefore reduced and the meaning of the activity differs from the intended meaning in *Mfa7.4* LAB. Likewise, due to Mrs. Nkosi's selective use of

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[21] Only two of the six learners record the answers to Activity 4 in their notebooks.

[22] Five different versions of the perimeter formula were recorded in the learners' notebooks.

> P = (2XL) + (2XB)
> P = L+L+B+B
> P = 2(L+B)
> P = 2L + 2B
> P = 2lengths + 2breadths
> (Extract from Mrs. Nkosi's learner notebooks)

Mfa7.4 LAB, Activity 4 appears to be semantically separated from Activity 5. In this way, the mathematical complexity of Activity 4 is reduced from a task in which area and perimeter is explored as measurements of two-dimensional space, to a task where learners simply have to decide which shape is bigger.

Although Mrs. Nkosi used *Mfa7* exclusively in the teaching of measurement, her selective use of the textbook had the effect of reducing the mathematical complexity of the tasks. In so doing, the mathematical knowledge presented to learners was fragmented. The learner notebooks therefore suggest that Mrs. Nkosi did not grasp the logic of the textbook. She therefore appears not to demonstrate access to the recognition or realization rules of the textbook's practices.

5.3.5 Summary

In summary, Mrs. Nkosi's classroom practice can be described as including whole class teaching and group work where whole class teaching is the dominant mode. She employed exposition, instruction, explanation, and questioning in her teaching. The questions used by Mrs. Nkosi were mainly factual recall questions rather than questions demanding reasoning. Her teaching was characterised by frequent repetition and restatement which reinforced memorisation of mathematical knowledge. In addition, she stressed procedures rather than the underlying principles of mathematical knowledge and the pacing of her teaching was extremely slow.

Mrs. Nkosi used *Mfa7* LAB exclusively and selectively. The mathematics presented by Mrs. Nkosi is displayed in Table 5.6 and is compared to the mathematics intended by the textbook, *Mfa7* LAB.

Table 5.6 Comparing mathematics presented by Mrs. Nkosi with *Mfa7.4* LAB

	Mrs. Nkosi	*Mfa7* LAB
Mathematics knowledge to be acquired by learners	• Different ways of measurement e.g. using string etc. other than using a ruler. • Learners attempt exercise questions on concepts of length without doing the developmental activities. • Applied area and perimeter formulas of a rectangle	• Lines are measured using a unit of length. • Lengths can be compared with a unit of length. • The size of the unit of length affects the measurement of a line • The need for standard units of measurement. • Derive formulas for perimeter and area

Table 5.7 below summarises the teacher's pedagogy and compares it to the pedagogy of *Mfa7.4* LAB, which was established in Chapter 4 of this thesis

Table 5.7: Comparing Mrs. Nkosi's pedagogy with *Mfa7.4* LAB

	Mrs. Nkosi	*Mfa7* LAB
Ideal learner	A learner who is: • dependent on teacher to learn mathematics. • requires mathematical knowledge to be presented by teacher. • unable to monitor own learning • works individually and co-operatively with other learners. • engages in discussion with the teacher and the learner • undifferentiated in terms of ability	A learner who: • is capable of working independently of the teacher. • Discovers mathematical knowledge through exploration. • Reflects and monitors own learning • Works co-operatively with other learners. • Engages in discussion with other learners • is undifferentiated in terms of ability
Ideal teacher	A teacher who: • uses inductive and deductive teaching approaches • facilitates question-and-answer discussions.	A facilitator who: • uses an inductive teaching approach • facilitates discussion in groups and whole class
Ideal classroom	A classroom in which: • teacher-learner interaction privileged over learner-learner interaction. • Discussion in groups and whole class. • weak framing between teacher and learner.	A classroom in which: • learner-learner interaction is privileged over learner–teacher interactions • discussion in groups and the whole class is encouraged • weak framing between teacher and learner.
Learning and teaching mathematics	Mathematics is learnt and taught: • without solution strategies or worked examples provided. • through exploration • actively and practically • deductively • through discussion with the teacher. • by foregrounding procedures • by not developing the principles of mathematics	Mathematics is learnt and taught: • without solution strategies or worked examples provided. • through exploration. • actively and practically. • inductively • through discussion with other learners. • by backgrounding procedures • by developing the principles of mathematics

Table 5.7 illustrates that the Mrs. Nkosi's pedagogy contained elements of the pedagogy of *Mfa7* LAB and her preferred pedagogy. Mrs. Nkosi's attempt at using an inductive teaching approach conflicted with her preferred mode of deductive teaching, resulting in a hybrid pedagogy which fragmented and reduced the mathematical complexity of the textbook's tasks presented to learners. Table 5.6 illustrates that Mrs. Nkosi did not achieve all the learning outcomes set out by *Mfa7* LAB. This I have argued is a result of the partial embedding of mathematics knowledge in the textbook, her selective use of *Mfa7* LAB and her inability to implement an inductive pedagogy effectively.

Mrs. Nkosi recontextualized the practices of the textbook by proceduralising and fragmenting mathematics. Although her preferred pedagogy differed considerably from pedagogy privileged by the textbook, Mrs. Nkosi nevertheless attempted to implement the textbook's practices in her classroom. She therefore attempted to affiliate with the practices of the textbook. However, her preferred pedagogy clashed with the textbook's pedagogy. I would argue that, Mrs. Nkosi could not implement the practices of the textbook successfully because she had not gained access to the recognition and realisation rules of the textbook's practices and was positioned as a dependent.

5.4 Conclusion

In this chapter I have analysed the video-recorded lessons, learner notebooks and two interviews of Mrs. Tyandela and Mrs. Nkosi. The analysis attempted to present the preferred pedagogy of each teacher, the relationship between the teacher's preferred pedagogy and the pedagogy employed while using *Mfa7* LAB, the teacher's construction of mathematics and learners and the teacher's use of *Mfa7.4* LAB to construct the teaching of measurement.

Both teachers attempted to use the textbook as a guide to their teaching. Mrs. Tyandela appeared to be more successful at using the textbook than Mrs. Nkosi was. The differential use of the textbook by the two teachers can probably be attributed to the differences in the professional experience and qualifications of the two teachers. Mrs. Tyandela had 14 years experience of teaching compared to the 5 years teaching experience Mrs. Nkosi had. At the time of the research project, Mrs. Nkosi was teaching mathematics to grade 7 learners for the first time. In addition, Mrs. Tyandela had a longer history of INSET and participated as a leader teacher in an INSET project at the time of the research. This suggests that Mrs. Tyandela had already been inducted into learner-centred, inductive pedagogy and could therefore easily manage to grasp the logic of the textbook's inductive pedagogy and successfully implement this in her classroom. In the next chapter, I consider the pedagogic practices of the other two teachers.

Chapter 6

Analysis of teachers' use of the Maths for all textbook: Part 2

6.1 Introduction

In the previous chapter I described the pedagogic practices of two teachers, Mrs Tyandela and Mrs Nkosi who affiliated with the practices of *Mfa7* LAB. This chapter focuses on the pedagogic practices of the other two teachers, Mr Faku and Mr Mafilika.

In this chapter, I examine both teachers' classroom practice by analysing the interview data, the video-recorded lesson and the entries in the teachers' learner notebooks. For each teacher, I first examine the teacher's preferred mode of teaching and compare it to the mode privileged by *Mfa7* LAB. I then construct the teacher's classroom practice from the video-recorded lesson and the learner notebooks. This analysis at the same time attempts to describe the teacher's construction of learners and mathematics and compares the teacher's construction with the textbook's construction of learners and mathematics. In addition, I examine how the teacher used *Mfa7* LAB to design his lessons for the teaching of measurement. Furthermore, the analysis seeks to establish the relationship between the teachers' classroom practice and the practices of the textbook. In other words, the analysis attempts to ascertain whether teachers affiliate with or objectify the practices of the textbook. In conclusion, I summarise and compare the four teachers' pedagogic practice and use of textbooks with their learners.

6.2. Mr Faku's classroom practice

6.2.1 Preferred mode of teaching

In this section I describe the teacher's preferred mode of teaching and compare it to the mode privileged by *Mfa7* LAB. In the interview, the teacher explained how he typically teaches mathematics:

> Whenever I introduce a lesson, I try to show them how do it, that calculation. Um I try to make the steps as long, I try to make it in detail. Some of them usually raise their hands and say it is too long you don't need this such and such. Then you know they really understand and at least they have an eye for such things.

and

> Usually I give them individual work and then only when we doing corrections if it was a homework. Anyway whenever we do corrections, we do corrections on the board and if you maybe see on the video, my children are grouped and when we do corrections in turns. Each group has got to have somebody on the day who is going to go up on the board and do that. So they also do that in turns, in turns in their groups.
> (Extract from Interview 2)

The above extracts illustrate that the teacher preferred to provide learners with examples in which he outlined the procedure or algorithm for a particular mathematical topic and then followed these examples with practice exercises which learners did individually and which the teacher publicly marked on the board. The teacher's typical teaching style can be described as a deductive pedagogy which foregrounds the learning of procedures. The teacher's preferred teaching style is reflected in his comments in the interview about his preference for another textbook:

> It [the other mathematics textbook – SJ] has lots of exercises and I have used it for a long time so it is familiar but it covers the 1991 syllabus.
> (Extract from Interview 1)

Mr. Faku found *Mfa7* LAB unsuitable for his needs because it does not contain sufficient practice exercises. He preferred a textbook which provides examples and several practice exercises. The teacher's preference of textbooks reflects his preferred teaching style, which is largely deductive and is therefore different from the inductive, exploratory pedagogy embodied in *Mfa7* LAB. In contrast to Mrs. Tyandela and Mrs. Nkosi, Mr. Faku did not use *Mfa7* LAB as a pedagogic text for himself.

It appears therefore that Mr. Faku did not affiliate with the textbook's practices, as it does not serve his pedagogic needs. The analysis below attempts to provide additional evidence for this claim and explores how a teacher who objectifies the textbook's practices uses this textbook in his classroom practice. I now examine the teacher's classroom practice in the video-recorded lesson.

6.2.2 Classroom practice constructed from the video-recorded lesson

The video-recorded lesson was conducted mainly in Xhosa with English being used for mathematical terminology and for reading from the textbook. The teacher started the lesson by informing learners that they were going to mark their homework (exercise questions 8d and 9 from *Modern Basic Mathematics* page 120) on the conversion of units of measurement. Individual learners were called to the board to provide the answers to the homework questions and to answer questions from the teacher.

Appendix 6.1 shows the different tasks in the lesson, the time spent on each task and the actions of the teachers and learners. Appendix 6.1 illustrates that the teacher worked with the whole class for the entire lesson. Although the learners were seated together in groups, they did not engage in group discussions in the lesson. The teacher controlled communication in the lesson in that he asked all the questions and he decided who should answer the questions. No official learner-learner interaction was promoted in the lesson and learner communication was solely in response to the teacher's questions. Teacher-learner interaction appeared to be privileged over learner-learner interaction in the lesson which therefore exhibited strong framing relations.

Most of lesson was structured around publicly marking the homework exercise questions on the board. As I shall go on to illustrate, the teacher used questions to either rehearse the procedure for converting from one unit of measurement to another, or to assist learners who were not yet proficient in conversion of units of measurement. For example, in the extract below, the teacher questioned a learner who had difficulty in converting 723 m to centimetres:

> T: How many centimetres make a metre?
> L: 100
> T: Which is bigger, a centimetre or a metre?
> L: a metre
> T: therefore this number [723m – SJ] is from a bigger unit to a smaller so is it so supposed to be bigger or smaller?
> L: Bigger
> T: So, it is supposed to be bigger. What are we going to do now? We multiply 723 times 100
> […]
> T: Which way the comma should move? How many times?
> L: three times.
> T: Why, because we have 100.
> L: two times.
> T: Right or the left.
> L: left.
> T: Do you increase or decrease this number?
> L: to the right.
> T: So you move it twice to the right. So what are you putting in these spaces.
> L: Zeros
> T: then what is your answer?
> C: 72 300 cm
> (Extract from video)

Almost all the learners who came to the board were questioned in a similar fashion and when a learner was unable to respond, the teacher directed the questions at the class. The teacher therefore employed question-and-answer discussion to rehearse knowledge that learners should have acquired in previous lessons and to assist learners who were struggling to convert different units of measurement.

The repetition of questions appeared to provide learners with several opportunities in the lesson to learn and memorise the procedure for the conversion of units. The questions also served to guide learners through the different steps of this procedure. The teacher therefore constituted mathematics as a set of procedures and rules that were to be memorised and transmitted to learners through careful sequencing of questions or prompts.

The teacher appeared to use the board to publicly assess whether learners had acquired the required mathematical knowledge. The board was therefore used as an important pedagogic resource in this lesson. Learners' public display allowed the teacher to monitor their acquisition of mathematics while at the same time other learners in the class were expected to listen, watch and learn from the learner at the board. The teacher responded to a learner who was unable to do a problem on the board by saying 'these are the people who don't pay attention when others are doing the work on the board.'

The board thus served as a space for the communal inscription of mathematics while at the same time learners' solutions and answers to the questions posed by the teacher were used to rehearse the procedure for converting units of measurement. In addition, the teacher recruited learners as pedagogues who were asked to make their performances public so that theirs and others can be corrected. The teacher expected learners to learn from each other through his mediation and not by communicating directly with each other. In this way, the teacher positioned himself as the primary mathematical expert in the classroom.

The use of the board to publicly monitor learners possibly explains the teacher's lack of direct engagement with the learners' notebooks. Only one of the six notebooks in my sample was marked and signed by the teacher while the learners either marked their own notebooks or other learners' notebooks. The notebooks did not all contain the same number of entries and not all the learners pasted the photocopied pages provided by the teacher into their notebooks. The missing entries from learner's notebooks could be due to the learner's absence from class when those entries were recorded, or learners had not completed the work assigned to them by the teacher, or a combination of these factors. The teacher acknowledged in the interview that it was difficult for him to monitor learners individually.

> But it is quite hard because there is not much contact with them. We have a big group really to observe them individually.
> (Extract from Interview 2)

The teacher was unable to subject learners to individual evaluation and engaged in group-evaluation through the use of the board. The teacher therefore used the board both as a pedagogic resource and as a group monitoring technique.

In summary, the dominant mode of teaching in the video-recorded lesson appeared to be teacher-directed question-and-answer discussion with little if any official learner-learner interaction. The teacher described his usual practice as consisting of exposition, individual practising of algorithms and communal marking of homework. The teacher controlled the pacing of the lesson since the whole class was expected to participate in the lesson irrespective of whether they mastered the procedure for the conversion of units. Thus the lesson appeared to exhibit strong framing relations.

The teacher assumed that learners could reproduce the procedures and were capable of learning from the public display of mathematics by other learners. The teacher tended to explicitly transmit mathematics and made the criteria for the production of mathematics visible to learners through presenting mathematics as a set of procedures to be memorised. In the video-recorded lesson, the teacher employed a deductive pedagogy which foregrounded the learning of procedures. The pedagogy used in this lesson is consistent with what the teacher stated to be his preferred style of teaching. From the above discussion, it is evident that the teacher's classroom practice differs from the practices of the textbook. This indicates that the Mr. Faku did not affiliate with the practices of the textbook and can be classified as an *objectifier*. The analysis which follows seeks to establish the extent to which Mr. Faku objectifies the textbook and attempts to ascertain how the textbook practices are transformed when it is incorporated into his classroom practice. An analysis of the teacher's learner notebooks as further evidence of his classroom practice is presented below.

6.2.3 Classroom practice constructed from the notebooks

For the measurement section, the learner notebooks contained photocopied pages from different textbooks, which comprised notes, tasks, examples and important formulas to remember. The notebooks also contained learner productions in the form of answers or solutions to tasks. A detailed description of the different entries in the notebooks is contained in Appendix 6.2.

Learners also recorded worked examples from the board in their notebooks as exemplary solutions besides the examples contained in the photocopied pages. The presence of these worked examples verifies the teacher's practice of employing a deductive approach to the teaching of mathematics.

In contrast to Mrs Nkosi and comparable to Mrs Tyandela, the teacher's practice of publicly marking homework tasks ensured that learners had the opportunity of recording the corrected version of the solutions into their notebooks. Although learner notebooks, cannot and certainly in Mr. Faku's class did not, constitute complete records of the mathematics lessons, Mr. Faku's learners could use their notebooks for future reference when preparing for tests and examinations since the notebooks contained the requirements of the tasks and the corrected solutions of the tasks.

The video-recorded lesson, the learner notebooks and the interviews with the teacher testify to his preferred pedagogy, which can be characterised as teaching mathematics deductively with an emphasis on the learning of procedures. In addition, the notebooks illustrate his construction of mathematics as a set of procedures and rules that need to be memorised. The pedagogy of this teacher differed from the pedagogy of *Mfa7* LAB. A comparison between the teacher's pedagogy and the pedagogy of *Mfa7* LAB is considered later in this chapter. In the next section, I examine the teacher's design of the teaching of measurement.

6.2.4 Use of textbooks to design the teaching of measurement

In this section, the video-recorded lesson is contextualised and positioned within the teacher's sequence of lessons in measurement and I examine in more detail how the teacher used *Mfa7.4* LAB in the teaching of measurement.

Table 6.1 below illustrates that the teacher dealt with the sub-topics length, perimeter and area that corresponded to the sub-topics in *Mfa7.4* LAB. In contrast to *Mfa7.4* LAB, his major focus for the section on length was on estimation and conversion of units, which is backgrounded in *Mfa7.4* LAB. In the section on area and perimeter, the teacher focused on the application of area and perimeter formulas for rectangles. The teacher's design of the teaching of measurement appears to be coherent, and as I will discuss later his selection of tasks from *Mfa7.4* LAB, occurs in such a way as to preserve the coherence of his design of the teaching of measurement.

Table 6.1 is constructed from the learner notebooks and illustrates the textbooks used, the tasks and notes provided to learners, a description of the tasks and the concepts that learners were to acquire. The shaded parts of the table refer to the teacher's selection from *Mfa7* LAB. A day-to-day description of the notebook entries is contained in Appendix 6.2.

Table 6.1: Mr. Faku's design of the teaching of measurement

Source	Description of tasks	Form of distribution	Concepts to be acquired
Mfa7 LAB	Page of 65 and 66 photocopied onto a single page that includes the outcome statements from the Maths for all LAB and Activity 1.	photocopy	Measuring lines using informal measuring strategies.
Maths Today	A table involving appropriate units of measurement, estimating measurements, actual measurements, difference between the estimated and the actual measurement.	photocopy	Measuring using formal measuring strategies and estimating length.
Modern Basic Mathematics	A note on the base unit of length in SI that is the metre and conversions of units of measurement. Exercises where they practice converting units of measurement.	Photocopy	Converting units of measurement.
Mfa7 LAB	Page 68: Exercise 1, question 1	Photocopy	Non-standard units of length
Modern Basic Mathematics	A photocopied page defining 'perimeter' Practice exercises on perimeter'.	Photocopy Photocopy & written	Practising using perimeter formula.
Mfa7 LAB	Page 72: Activity 5	Photocopy	Comparing shapes on grids
Modern Basic Mathematics and other	Task developing the formula for the area of a rectangle. Practise exercises on area (tasks).	Photocopy Written	Practising area formula.

Key: Shaded sections show tasks taken from *Mfa7.4* LAB

Table 6.1 illustrates that the teacher used three different textbooks as resources to construct the teaching of measurement. In the interviews, the teacher acknowledged that he used *Modern Basic Mathematics*, *Maths Today* and *Mfa7* LAB and that he preferred *Modern Basic Mathematics* to *Mfa7* LAB. *Modern Basic Mathematics* appeared to be the main textbook around which he structured the teaching of measurement, and the other two textbooks are resources that he acted on selectively to supplement the teaching of measurement. The teacher thus selectively recruited from *Mfa7* LAB to constitute his teaching practices.

As Table 6.1 shows all three tasks from *Mfa7.4* LAB appear to be positioned at the beginning or end of the teacher's sub-sections of measurement. Activity 1 appears to be used as an introductory task, Question 1 from Exercise 1 (*Mfa7.4* LAB: 68) was inserted after the teacher dealt with conversion of units and before the section on perimeter and Activity 5 was completed after perimeter and before area of a rectangle. The teacher's selections from *Mfa7* LAB are incorporated into his design of the teaching of measurement which concentrated on the conversion of units and the application of area and perimeter formulas for rectangles. Table 6.2 shows the teacher's selection from *Mfa7.4* LAB and a comparison between the mathematics presented in the textbook and the mathematics presented by the teacher.

Table 6.2 Comparing mathematics presented by Mr. Faku with *Mfa7.4* LAB

Description of activity	**Mathematical knowledge to be explored by learners**	**Mathematical knowledge summarised in bullet points**	**Mathematical knowledge made explicit by the teacher**
Activity 1 Three roads represented as lines that have to be measured using a variety of resources such as string and tracing paper.	• How do we measure lines? • How do we compare the lengths of lines?	Activity 1 in conjunction with Activity 2 leads to the following conclusions: • Lines are measured using a unit of length. • Comparison of length is possible with a unit of length. • The size of the unit of length affects the measurement of a line.	• Emphasises different ways of measurement e.g. using string etc. other than using a ruler. • Compares lines using ruler measurement.
Exercise 1 Question 1 Learners have to decide which shape, a triangle and rectangle formed from knotted string, is bigger and what the unit of length is.	Practice question where learners have to recognise that the non-standard unit of length is the space between the knots in the string.	Answers in *Mfa7.4* TRB: The shapes are the same size and the unit of length is the space between the knots.	Teacher's explanation to learners in video-recorded lesson: The unit of length has to be measured with a ruler and should be given in centimetres and millimetres[1].
Activity 5 Comparing the sizes of two-dimensional shapes using grids	• How do we measure two-dimensional shapes?	Perimeter and area is defined as two ways of measuring two-dimensional shapes. Perimeters of shapes are equal but areas differ.	Shapes are equal. There are no references to area or perimeter in the corrections (the teacher's privileged meaning[2]) although learners' answers indicate that they used a range of criteria to decide on the size of the shapes e.g. perimeter, area, length and breadth of shape.

[1] In the video-recorded lesson, the teacher interpreted Question 1 from Exercise 1 [Mfa7.4 LAB: 68]), which requires learners to draw the unit of length represented in the diagrams:

> T: Use your ruler. Which unit does your ruler have?
> L: centimetres and millimetres.
> T: You take your ruler and measure between these knots and then you explain which unit of length has been used.
> (Extract from video)

[2] The corrections from the learner notebooks to questions 1–3 of Activity 5 are stated below:

> They are all equal.
> They are all equal.
> Measured
> [Extract from Mr. Faku's learner notebooks]

Table 6.2 illustrates that the teacher's interpretation of the tasks differed from that intended by *Mfa7.4* LAB. Mr Faku used Activity 1 in isolation of Activity 2. As discussed in Chapter 4 and 5, the treatment of Activity 1 in isolation of Activity 2 potentially reduces the mathematical complexity of the activity. Activity 1 merely becomes a task of finding the longest road (line), an aim which is different from the intention of *Mfa7* LAB. The teacher's use of Activity 5 (*Mfa7.4* LAB: 72) privileged a different meaning to that intended by *Mfa7.4* LAB and, I would suggest reduces the mathematical complexity of the task from exploring area and perimeter as measures of the size of two-dimensional shapes, to a counting exercise. This example illustrates the potential for tasks in the textbook to be reduced from tasks exploring the underlying ideas of measurement, to less complex tasks in which lines or shapes are compared. As I argued in Chapter 4, the potential for this simplification of tasks lies in the fact that the textbook does not always make the mathematical knowledge of the activities explicit. In addition, the teacher's explanation of question 1, exercise 1 indicates that he did not understand that the knots in the string are informal units of length. It appears that by selecting one task from a sequence of activities the teacher is not able to follow the logic of the task.

In summary, the teacher does not rely on one textbook to design his teaching of the measurement topic. He draws on a number of textbooks and recruits them selectively to construct the teaching of the topic, measurement. The tasks selected from *Mfa7.4* LAB are recontextualized and the mathematical complexity of the tasks tends to be reduced. The tasks from *Mfa7.4* LAB appear not to disrupt his design of the teaching of measurement, which focuses on conversion of units, application of perimeter and area formulas. This discussion demonstrates that although the teacher uses *Mfa7* LAB in his teaching, he subordinates the textbook to his classroom practice.

6.2.5 Summary

From the above discussion, it is evident that Mr. Faku did not identify with the practices of the textbook, *Mfa7* LAB as Mrs. Tyandela did. Both Mr. Faku and Mrs. Nkosi acted selectively on the textbook. In fact, Mr. Faku's teaching practices differed considerably from the teaching practices inscribed in *Mfa7* LAB. The teacher's selective recruitment from the textbook constructs him as a *positive objectifier* in that he finds parts of the textbook useful to his teaching but does not identify with the practices of the textbook as a whole. The textbook therefore serves as a resource for recruitment in the construction of his teaching practice.

Table 6.3 summarises Mr. Faku's pedagogy and compares it to the pedagogy privileged in *Mfa7.4* LAB, which was established in chapter 4 of this thesis.

Table 6.3: Comparing Mr. Faku's pedagogy with *Mfa7.4* LAB

	Mr. Faku	***Mfa7* LAB**
Ideal learner	A learner who : • depends on the teacher to learn mathematics. • is presented with mathematical knowledge. • is monitored by the teacher publicly. • works mainly individually and co-operatively at times. • engages in discussion with the teacher. • is undifferentiated in terms of ability	A learner who: • is capable of working independently of the teacher. • Discovers mathematical knowledge through exploration. • reflects and monitors own learning • Works co-operatively with other learners. • engages in discussion with other learners • is undifferentiated in terms of ability
Ideal teacher	A teacher who • positions himself as the primary curriculum authority in the class. • facilitates question-and-answer discussions with the whole class. • monitors learning communally. • provides resources for learners.	A facilitator who: • manages class time • facilitates discussion as opposed to explicit teaching • manages learners' mathematical progress • provides resources for learners
Ideal classroom	A classroom in which: • teacher-learner interaction is privileged over learner-learner interaction. • discussion with whole class is encouraged. • strong framing between teacher and learner exists.	A classroom in which: • learner-learner interaction is privileged over learner–teacher interactions • discussion in groups and the whole class is encouraged • weak framing between teacher and learner.
Learning and teaching mathematics	Mathematics is learnt: • with worked examples • through exposition • deductively • through memorising and practising procedures. • Through public display of mathematical knowledge. • by foregrounding procedures • by not developing the principles of mathematics	Mathematics is learnt: • without solution strategies or worked examples provided. • through exploration • inductively • actively and practically • through discussion with other learners. • by backgrounding procedures • by developing the principles of mathematics

Table 6.3 illustrates that the deductive pedagogy of the teacher differs significantly from the inductive exploratory pedagogy embodied in *Mfa7.4* LAB. In addition, the identities and inter-relationships in his classroom differs from the identities and relationships

promoted by *Mfa7* LAB. Mr. Faku uses the textbook as a resource which he draws on selectively and recontextualizes to conform to his preferred pedagogy. As a result of his selective use of the textbook, the complexity of the tasks set out there is reduced and the mathematics presented there is fragmented. However, his selections from *Mfa7* LAB do not disrupt his overall design of the teaching of measurement.

In the next section, I discuss the classroom practices of Mr. Mafilika, who, like Mr. Faku, did not identify completely with the practices of *Mfa7* LAB.

6.3 Mr Mafilika's classroom practice

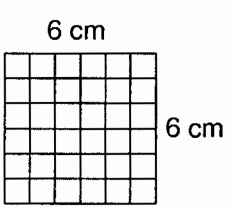
6.3.1 Preferred teaching mode of teaching

In this section I describe the teacher's preferred mode of teaching and then discuss the extent to which the video-recorded lesson serves as an exemplar of his preferred teaching style. In the interview, the teacher explained how he typically teaches mathematics:

> T: Normally, I write examples on the chalkboard, two, three or four and then I will explain each and every step I write, how to come to the next step until you get to the answer. And then, if there is anyone who doesn't understand I love that, I love that particular one to read the question. Try to explain again or to answer the question specifically. When dealing with measurement I like to be practical because they must know exactly what they are measuring in terms of length where we use centimetre, millimetres [...]. Before we, before I write the method on the chalkboard, we go practically, physically out, go measure the length of the wall, breadth, length as well, all four sides. Then we discuss in groups which shorter method we think we can use to get to the answer. [...] I leave them to copy examples into their books and I give them classwork to reinforce what they have learnt. Then I go on for the next two or three days to see whether they have registered, they mastered what they have learnt, that particular concept before going onto the next topic.
> (extract from Interview 2)

The teacher described his preferred mode of teaching as consisting of explanations, practical demonstrations, providing worked examples and opportunities for practice. An analysis of the learner notebooks confirmed the teacher's practice of using worked examples and practice exercises. An example from a learner notebook is shown below:

Area = L X B or L X L
$= 6 \text{ X } 6 \text{ cm}^2$
$= 36 \text{ cm}^2$
(Extract from Mr. Mafilika's learner notebooks)



This example is followed by several practice exercises on the application of the formula for the area of a rectangle. The learner notebooks, together with the teacher's description of his preferred mode of teaching, suggest that the teacher constructs mathematics as a set of rules, definitions and procedures, and that he teaches mathematics deductively foregrounding the learning of procedures. The teacher's preferred mode of teaching is different to the inductive approach to learning mathematics privileged in *Mfa7.4* LAB, which possibly explains his reasons for not using *Mfa7* LAB in his teaching.

An analysis of the learner notebooks of this teacher revealed that the video-recorded lesson was the only lesson for the measurement topic in which the teacher used *Mfa7* LAB. The photocopied page of Activity 5 (*Mfa7.4* LAB: 75) which he used in this lesson and the answers to this activity were not included in the learners' notebooks. In the interview, the teacher acknowledged that he did not employ his preferred teaching mode in the video-recorded lesson. It appears that the teacher used *Mfa7* LAB in the video-recorded lesson because he had agreed to participate in the research project. Despite this, the video-recorded lesson still provides valuable insights into how the teacher used *Mfa7* LAB and his pedagogic practice. The above discussion suggests that Mr. Mafilika did not affiliate with the practices of the textbook. The analysis below seeks to provide further evidence for this claim. In the next section, I examine the video-recorded lesson of Mr. Mafilika.

6.3.2 Classroom practice constructed from the video-recorded lesson

The teacher started the lesson by handing out photocopies of Activity 5 (*Mfa7.4* LAB: 72) to each learner. This activity involved the comparison of two-dimensional shapes on a triangular grid and on a rectangular grid. The learners were required to decide which figure on each grid was bigger and to explain how they worked out their answers.

The teacher read, explained and translated the task to learners, which he requested that they undertake in groups. Learners were asked to compare the hexagon and star on the triangular grid and the two rectangles on the square grid. The teacher then asked learners again to compare the size of rectangles on the square grids, find the perimeter of shapes on triangular grid and the perimeter of rectangles on the square grid. Learners were then required to work out the area of all the shapes and finally, to draw grids that were not triangular or square. A detailed outline of the lesson is contained in Appendix 6.3 which shows the different tasks in the lesson, the time spent on each task and the actions of the teacher and the learners.

Appendix 6.3 illustrates that the teacher appeared to interchange groupwork and question-and-answer sessions with the whole class and that he employed exposition as well. In the lesson, the teacher only publicly questioned each group six times and only one learner from each group answered the teacher's questions. So although the teacher used groupwork, in which learners communicated and interacted with each other, he maintained control over communication in the lesson since he asked all the questions, decided who should answer the questions and when they should answer. Thus the framing relations in the classroom were strong.

Appendix 6.3 illustrates that in this lesson, the teacher acted as a facilitator by explaining the tasks to learners and then allowing them to discuss the task amongst themselves. The teacher generally did not appear to assist learners with the tasks while they were working in groups. Once in the course of the lesson, the teacher assisted one group to decide which shape on the triangular grid was bigger and on another occasion he clarified the same task to another group. On all the other occasions, the teacher's only interaction with the learners while they were working in their groups was to check whether they completed the tasks assigned to them. In this regard the teacher's mode of teaching in this lesson appeared to resonate with the form of pedagogy privileged in the textbook namely that learners should learn mathematics independently of the teacher and cooperatively with their peers.

The teacher started the lesson by asking the learners to determine which of the shapes on each grid (Activity 5, *Mfa7.4* LAB: 75) was bigger. The learners were required to discuss this task in their groups and each group was given an opportunity to answer. All the groups said that the hexagon was bigger than the star and that they had counted triangles to find the answer. The teacher enquired whether any one had a different answer but no one had. It appeared that the teacher expected different answers from the learners, a point I will return to later in this discussion.

The teacher then instructed the learners to find the perimeter of the shapes. For the first time in this lesson, the teacher introduced the term perimeter. Until this stage, the teacher did not inform learners that the lesson focused on area and perimeter. He also did not tell them that counting triangles and squares is a way of finding the area of the shapes. All the learners except for one group determined that the hexagon has a bigger perimeter than the star. In fact, the hexagon and star have the same perimeter but the teacher did not intervene to correct responses, nor did he ask the learners to explain how they arrived at their answers. The teacher thus avoided evaluating learners' responses and did not use their responses as a pedagogic resource for developing their understanding of perimeter.

The teacher also did not explain to learners how to find the perimeter of the hexagon and the star on the triangular grid and did not return to this question in the lesson. Instead he moved on to the next point in the lesson. He proceeded to explain to the class how he worked out the perimeter of rectangles on the square grid. The teacher explicitly told the learners that the perimeters of the rectangles were the same and reminded them that they initially decided that the top rectangle (Activity 5, *Mfa7.4* LAB: 75) was bigger than the bottom.

> T: Are they not the same? But our answer was the top one was bigger. Am I wrong? The perimeter of the two rectangles is the same. Is the area still the same? Let us make sure, let's find out again. Remember for the perimeter, we counted right around. Is the area still the same? Who has the answer?
> (Extract from video)

The learners were then instructed to find the area of the rectangles again, which they did by counting the squares. The teacher concluded by saying:

> T: So you can see that in this first drawing, the second one, the perimeter was the same but the area, the inside surface was not the same. So when we speak of perimeter, we speak of the measurement right around the drawing. When we speak about area, we speak about the surface, the plane, inside the drawing. (Extract from video)

It appeared therefore that the teacher started off by attempting to use Activity 5 inductively to develop the concepts of perimeter and area. However, he ended up directing the learners to finding the areas of rectangles and then providing them with the definitions of perimeter and area. In the extract from the interview below, the teacher explained what he expected to happen in the lesson:

> T: Ja, these two on the papers in front of them [referring to the rectangles on the square grid- SJ]. So the answers I was expecting of them, some they would count the number of blocks inside the shaded part, then count the next one. If this one is more, has more blocks than the other one, then this one is

bigger. In that case they have used the area to find out which one is bigger. Although by looking at it, this one looks like bigger than the other one. [...] so the mechanism to arrive at the answer is either you use area or your perimeter. **So they could not give me the correct answer before they could learn about area and perimeter.** They must learn about area and perimeter first before they can utilise the knowledge they have and apply it here.
(Extract from Interview 2 – my emphasis)

The teacher expected learners to arrive at different answers but all the learners arrived at the same answer. All the learners found the sizes of the shapes by simply counting the number of triangles or squares. The teacher had expected that some learners would compare the inside of the shapes (area) while others would compare the border of the shapes (perimeter) and that this would lead to a discussion of area and perimeter as two measures for comparing shapes.

The notebooks revealed that the teacher had already taught perimeter of rectangles and the formula for the area of a rectangle before this lesson[3]. Yet the learners did not associate the present task with perimeter and area. The teacher resorted to explicitly telling learners to calculate the perimeter and the area of the shapes because he realised that the learners were not focusing on area and perimeter. The teacher therefore abandoned 'exploration' and substituted it with explicit transmission. In other words the teacher's deductive approach was in tension with the inductive approach privileged by *Mfa7.4* LAB and in the end produced a pedagogy which consisted of elements of both forms of pedagogy. The resultant task, however, reduced Activity 5 from one which develops the concept of area and perimeter to a counting exercise.

The learners spent about 11 minutes, more than a third of the lesson, discussing which shape is bigger and finding the area of the shapes, which in essence entailed counting triangles and squares. As a result the pace of the lesson was extremely slow and was controlled by the teacher. He decided on the amount of time required to work on a particular section and directed the sequence of the lesson by posing specific questions for the class to discuss. Learners were instructed to wait until all the groups completed the task

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[3] The teacher dealt with perimeter of rectangles but did not formalise it by stating the perimeter formula. Learners were expected to find the perimeters of figures that could be decomposed into rectangles. In addition, the teacher dealt with the area formula for a rectangle nd also extended the application to more complex shapes. The area of a right-angle triangle was also covered. The area of a rectangle and triangle appeared to be taught deductively and procedurally. A more detailed description is contained in Appendix 6.3.

before they were allowed to answer the questions. This illustrates that framing over pacing was strong.

In contrast to his preferred mode of teaching, which involved a deductive pedagogy foregrounding the learning of procedures, the teacher attempted to adopt an inductive, exploratory pedagogy privileged by *Mfa7.4* LAB. This he relinquished when the lesson did not progress according to his expectations. Thus although the video-recorded lesson contained elements of both a deductive as well as an inductive pedagogy, the teacher's dominant pedagogy was deductive.

It appears therefore, that like Mrs. Nkosi, Mr. Mafilika was not comfortable with the inductive pedagogy of the textbook and he did not implement the practices of the textbook successfully. His lesson reflected a tension between his preferred deductive style and the inductive pedagogy of the textbook. However, in contrast to Mrs. Nkosi there was no attempt by Mr. Mafilika to affiliate with the practices of textbook. As I will demonstrate in more detail, he found very little if any of *Mfa7* LAB useful for his classroom practice – to a large extent he negatively objectified the textbook.

6.3.3 Classroom practice constructed from the notebooks

For the measurement section, the notebooks contained learner productions in the form of answers or solutions to tasks. A detailed description of the different entries in the notebooks is contained in Appendix 6.4. In addition, learners recorded worked examples from the board into their notebooks as exemplary solutions. The presence of these worked examples confirms the teacher's practice of employing a deductive approach foregrounding the learning of procedures in the teaching of mathematics. Like Mr. Faku, the teacher publicly marked homework tasks which provided learners with the opportunity of recording the corrected version of the solutions into their notebooks.

In contrast to Mr. Faku's learner notebooks however, the requirements of the tasks or notes were absent from Mr Mafilika's learner notebooks. For example, in the example on area in the learners' notebooks, the task 'Calculate the area' was not recorded into the notebooks. The exclusion of the tasks from the notebooks suggests that the teacher did not write down the task on the board or that learners were not encouraged to write down the tasks.

Furthermore, calculations that did not state the initial task make the notebooks inadequate resources for future reference in preparation for tests or examinations. Learners were therefore required to rely on their memory to reconstruct the mathematics presented to them. In this way learners' access into the discourse of school mathematics was restricted.

As in the case of Mr Faku, the video-recorded lesson, the learner notebooks and the interviews with Mr. Mafilika's testified to his preferred pedagogy, which was deductive with an emphasis on learning and memorising procedures. This was different from the pedagogy privileged in *Mfa7* LAB. In the next section, I examine the teacher's use of the textbook to design the teaching of measurement.

6.3.4 Use of textbooks to design the teaching of measurement

The notebooks reflect that the teacher dealt with perimeter and area of rectangles and composite figures that can be divided into rectangles e.g. L-shaped or U-shaped figures and the area of right-angled triangles. A detailed description of the entries is contained in Appendix 6.4.

There is no indication in the notebooks of how the teacher developed the concept of perimeter. In the interview, the teacher described practical activities in which learners measured the length of the walls and classrooms to find the perimeters. In the notebooks, learners simply added the lengths of a figure to find the perimeter. It appeared from the notebooks that the teacher did not move towards formalising perimeter either by providing learners with a formula or deriving a formula for perimeter. As discussed in section 6.3.1, it appeared that the teacher presented the formula for the area of a rectangle which learners then applied in practice exercises. The teacher's design of the teaching of measurement differs from *Mfa7.4* LAB which inductively develops the concepts of area and perimeter and the formulas for area and perimeter. In addition, the teacher did not focus on length at all in his design of the teaching of measurement.

The notebooks also reflect that the teacher did not rely on *Mfa7* LAB to teach measurement. None of the activities or exercises from the book was recorded in the notebook, including the task used in the video-recorded lesson. In the interview the teacher explained that he used a range of textbooks, namely *Mathematics Explained*, *Classroom*

Mathematics and *Lessons in Mathematics* to teach mathematics but that he mainly used *Classroom Mathematics* for the teaching of measurement. As he explained in the interview, *Classroom Mathematics*:

> [explains] concepts easier and is more explicit and helps him [the learner – SJ] to make more progress and there are more exercises.
> (Extract from Interview 1)

Mr. Mafilika like Mr. Faku did not find *Mfa7* LAB appropriate for the teaching of measurement because it does not contain sufficient practice exercises and does not make mathematical knowledge sufficiently explicit.

6.3.5 Summary

As discussed above, Mr. Mafilika did not identify with the practices of the textbook. He used other textbooks which he selectively recruited for the design of the teaching of measurement. In contrast to Mr. Faku, Mr. Mafilika found little that was worthy of recruiting from *Mfa7* LAB in his constitution of teaching measurement. Mr. Mafilika can therefore be described as an *objectifier* who to a large extent negatively objectifies the practices of the textbook.

The preferred pedagogy of this teacher was reflected in interviews and notebooks whereas the video-recorded lesson constituted a hybrid of teacher's preferred pedagogy and the pedagogy privileged by *Mfa7.4* LAB. Table 6.4 summarises the teacher's preferred pedagogy and compares it to the pedagogy of *Mfa7.4* LAB, which was established in Chapter 4 of this thesis

Table 6.4: Comparing Mr. Mafilika's pedagogy with *Mfa7* LAB

	Mr. Mafilika	*Mfa7.4* LAB
Ideal learner	A learner who: • is dependent on teacher to learn mathematics. • learns mathematics presented by the teacher. • is monitored by the teacher. • works mainly individually and co-operatively at times • engages in discussion with the teacher and other learners • is undifferentiated in terms of ability. • practices algorithms to become proficient in procedures	A learner who: • is autonomous • discovers mathematical knowledge through exploration. • reflects and monitors own learning • works co-operatively with other learners. • engages in discussion with other learners • is undifferentiated in terms of ability • behaves like a mathematician • draws on familiar experiences and knowledge
Ideal teacher	A teacher who: • positions himself as the curriculum authority in the class • facilitates question-and-answer discussions with the whole class • ensures leaner discussion in groups.	A facilitator of the pedagogic space who: • manages class time • facilitates discussion as opposed to explicit teaching • manages learners' mathematical progress • provides resources for learners
Ideal classroom	A classroom in which: • teacher-learner interaction and learner-learner interaction takes place. • strong classification between teacher and learners. • discussion with whole class and in groups is encouraged. • freedom of expression is encouraged • strong framing over pace of lesson	A classroom in which: • learner-learner interaction is privileged over learner–teacher interactions • learners are considered 'equals' i.e. weak classification between learners • teacher-learner relationship is weakened i.e. framing is weak. • discussion in groups and the whole class is encouraged • freedom of expression is encouraged • weak framing over pace
Learning and teaching mathematics	Mathematics is learnt: • with worked examples • through exposition • deductively • through memorising and practising procedures. • through public display of mathematical knowledge. • by foregrounding procedures	Mathematics is learnt: • without solution strategies or worked examples provided. • through exploration • inductively • actively and practically • through discussion with other learners. • by backgrounding procedures

So far, I have discussed the pedagogic practices of all four teachers in this study. I have described their preferred teaching style and the teaching style employed while using *Mfa7* LAB. In addition, I have described how different teachers used *Mfa7* LAB in their construction of the teaching of measurement. In the conclusion of this chapter, I will summarise the form of recontextualization of the textbook by the different teachers. Firstly, I discuss how the teachers used the textbook with their learners.

6.4 Teachers' use of textbooks with learners

In this section, I examine how all the teachers in this study used textbooks with their learners. As I will illustrate, there appeared to be common practices in textbook use across the four teachers.

Table 6.5 below illustrates that none of the teachers provided learners with a personal mathematics textbook even though the research project in most cases provided the schools with sufficient copies for each learner in the research classroom. The reasons for not handing out the textbooks varied. All the teachers feared that learners would damage or lose the books while those teachers (Mrs. Tyandela and Mr. Faku) who taught more than one grade 7 class felt that they could not only provide one class with textbooks while the other classes did not have textbooks.

The information in Table 6.5 was obtained from the video-recorded lessons, interviews with the teachers.

Table 6.5 Learners' access to textbooks (*Mfa7* LAB and other)

	Have their own copies for use at school and home	**Have textbook for use in class,**	**Take textbook home for homework**	**Have no direct access to books but get photocopies**	**Have no access to books or photocopies**
Mrs. Nkosi		X	X (once a fortnight)		
Mrs. Tyandela				X	
Mr. Faku				X	
Mr. Mafilika				X (in video-recorded lesson)	X

As Table 6.5 shows all the teachers besides Mrs Nkosi used photocopies instead of the actual textbooks with their learners. As Mrs Tyandela explained in the interview, her reasons for not providing the learners with a personal textbook were as follows:

> You'll find that I don't just give it [tasks- SJ] during the school hours. Sometimes I ask them to go and finish it at home. And my experience, they don't come back with the books. They come with stories. Maybe it burnt. Maybe my baby brother was playing with the book. So it is better if I give them photocopies.
> (extract from Interview 2)

The other teachers had similar reasons to Mrs Tyandela. Even though Mrs Nkosi allowed learners to take the textbook home for homework or to prepare for tests, she regularly checked whether the books were returned. The teachers' use of photocopies in place of the actual textbooks is a practice instituted by teachers to protect the few resources they have from disappearing. However, limiting learners' access to textbooks has the effect of constructing the teacher as the only curriculum authority for the learners since they become dependent on the teacher's selection from the textbook.

Besides learners' restriction on access to the actual textbooks, the video-recorded lessons of the different teachers provide insight into how the teachers used Mfa7 LAB with their learners. Table 6.6 below shows how learners engaged with text in the different classes.

Table 6.6 Learners engagement with text

	Teacher reading text to learners	**Teacher interpreting and/or translating text for learners**	**Learners reading diagrammatic or numerical information only**[4]	**Learners reading text independently**	**Learners interpreting text on their own**
Mrs. Nkosi	X	X	X		
Mrs. Tyandela	X	X	X	X[5]	
Mr. Faku	X	X			
Mr. Mafilika	X	X	X		

All the teachers read, translated the text into Xhosa and interpreted the tasks for learners. Mrs. Tyandela was the only teacher who gave her learners the opportunity of reading aloud as a class from the textbook. However even she did not ask learners to interpret the text for themselves. In all the other classes, the learner's only engagement with the tasks was with the diagrams and not the written text. Learners were therefore reliant on the teacher for her/his interpretation of the task. The teachers therefore constructed the learners in the main as unable to do mathematics independently. The following extract from an interview with Mrs. Nkosi depicts learners as incompetent to use the textbooks independently of her.

> T: And another thing, their problem, they can't understand what is written on the textbooks. So you find that they give different answers but [pause – SJ] it is a problem to some of them. It is funny when I explain it when you do corrections, they do understand but when I told them today I'm not going to explain anything. You read this activity, you follow the instructions, you discuss in your groups. But you find those who are very slow, they won't get the correct answers.
> (Extract from Interview 2)

[4] Mr. Faku was not observed using a task from Mfa7 LAB with his learners. The only observation of him using the textbook was to clarify a homework task for learners.
[5] In this case the teacher instructed the learners to read aloud from the textbook.

The reasons offered by all the teachers for reading and explaining the text to learners was that the language of the textbook is complex and that the language (English) level of the learners is poor. As Mr Mafilika explained in the interview:

> T: That is a language problem there. It is a language problem there. See I am trying to communicate with them in English but I have repeated my explanation twice because they don't understand which means now I must switch to their mother tongue for them to understand what is required of them to do. So language is always a problem. You can't stick to English one way otherwise your lesson won't progress. So you have to mix at times because immediately you realise they don't understand.
> S: And can you explain why you read the questions of the Activity? You read the questions and then you explained this to the learners.
> T: As much that they didn't understand what I said, they wouldn't understand what they should read on the paper. So I had to make sure that they understand what is written there.
> (extract from Interview 2)

The learners' lack of continuous access to textbooks, and the teachers' practice of reading and interpreting the text for learners, denies learners the opportunity of engaging with texts on their own. Deciphering tasks from texts without the assistance of the teacher is a fundamental skill required in answering mathematics tests. Furthermore, the teacher's practice of restricting learners' engagement with text to that containing only numerical or diagrammatic information hampers learners' development of literacy skills and practices essential for access into the discourse of school mathematics.

6.5 Conclusion

In Chapter 5 and 6, I discussed the pedagogic practices of the four teachers in my study. Chapter 5 focussed on the pedagogic practices of Mrs. Tyandela and Mrs. Nkosi while Chapter 6 dealt with the pedagogic practices of Mr Faku and Mr. Mafilika. In both chapters I discussed the preferred teaching mode of the teacher and the teaching of measurement in particular, which revealed the extent to which *Mfa7* Lab was used by the teacher and the form in which the tasks of the textbook were realised within the teacher's practice.

The analysis illustrates that Mrs Tyandela and Mrs Nkosi affiliated with the textbook's practices and based their teaching of measurement on *Mfa7* LAB exclusively. The video-recorded lesson and notebooks of both teachers demonstrate attempts to implement the pedagogy of *Mfa7.4* LAB. Mrs. Tyandela demonstrated that she had access to the recognition and realisation rules of the practices of *Mfa7* LAB. Mrs. Nkosi however, demonstrated that she did not have access the recognition rules and the realisation rules of the pedagogy. In contrast to the two female teachers, the two male teachers, Mr Faku and Mr. Mafilika, both used *Mfa7* LAB selectively in the teaching of measurement and used *Mfa7* LAB as a resource of limited range. Both teachers therefore objectified *Mfa7* LAB with Mr. Faku selecting far more from it than Mr. Mafilika.

Table 6.7 below summarises the teachers' use of *Mfa7.4* LAB in the teaching of measurement, their relationship with the practices of the *Mfa7* LAB and the effects of their use of the textbook on the teaching of measurement.

Table 6.7: Teachers' use of textbooks

Teacher	**Relationship with Mfa7 LAB**	**Use of Mfa7 LAB for**	**Other textbooks used**	**Preferred pedagogy**	**Pedagogy used with Mfa7 LAB**	**Possible effects and consequences**
Tyandela	Associated with practices of textbook	• Every lesson • Used all the tasks in the sequence of Mfa7 LAB	None	inductive	inductive emphasising principles	• extremely slow pacing • coherent overall design • does not achieve all the learning outcomes of Mfa7 LAB • emphasises principles
Nkosi	associated with practices of textbook	• Every lesson • Selected different tasks	None	deductive	hybrid of inductive and deductive	• fragmented mathematical knowledge • reduction in mathematical complexity of tasks • fragmented overall design • does not achieve all the learning outcomes of *Mfa7* LAB • emphasising procedures
Faku	Objectifies practices of textbook positively	• Occasionally • Selected different tasks	range of textbooks	deductive emphasising procedures		• reduction in mathematical complexity of *Mfa7* tasks • coherent overall design
Mafilika	Objectifies practices of textbook negatively	• Only used in video lesson	range of textbooks	deductive emphasising procedures	hybrid of inductive and deductive	• fragmented mathematical knowledge • reduction in mathematical complexity of tasks • coherent overall design

The analysis presented in Chapter 5 and 6 illustrates a number of findings on textbook use by teachers. Firstly, all the teachers in this study used textbooks to structure their teaching of mathematical topics. It appears that textbooks were used as the main source of curriculum authority and represent an interpreted curriculum for teachers since current curriculum documents offer little guidance on what to teach in each grade. Textbooks therefore have the potential to influence teacher's choice of mathematics taught in classrooms. This study confirms the findings of the study conducted by Adler et al (2001) which, contrary to generalised findings of the Taylor & Vinjevold (1999), concluded that mathematics teachers use textbooks substantially in their teaching.

Secondly, most teachers in my study used textbooks selectively as resources to constitute their teaching practice. As the analysis demonstrates, selective use of textbooks has the potential to fragment the mathematics presented and could potentially lead to a reduction in the mathematical complexity of the tasks. Textbooks, such as *Mfa7* LAB, in which mathematical knowledge is partially embedded, exacerbate the potential fragmentation and reduction of complexity of the intended mathematical knowledge.

Thirdly, the capacity of *Mfa7* LAB to act as a pedagogic text for teachers and learners is restricted because aspects of the pedagogy cannot be transmitted discursively. Some aspects need to be transmitted tacitly through, for example INSET. Fourthly, the effective use of *Mfa7* LAB appears to be dependent on the teacher's expertise in using an inductive, exploratory pedagogy and the teacher's mathematical knowledge which allows the teacher to close the gap between the exploratory activities of the textbook and the intended mathematical outcomes of the textbook.

The teachers' use of *Mfa7* LAB in my study raises many issues around pedagogy, curriculum and textbook design. These issues are elaborated in the next chapter which concludes this dissertation.

Chapter 7

Discussion and conclusion

7.1 Introduction

In the concluding chapter of this thesis, I present a summary of the discussion, outline the limitations and strengths of the study and discuss the potential for further research. I conclude this chapter and dissertation with recommendations on textbook design, curriculum and policy development and teacher development which emerged from insights gained in this study.

7.2 Summary of dissertation

This thesis set out to answer the question, *What is the impact of Mfa7 LAB on Grade 7 mathematics teachers' classroom practice?* Implicit in this question is the notion that textbooks will inevitably be transformed when used by teachers in classrooms. Bernstein and Dowling's conception of recontextualization as transformation of pedagogic discourse provided the theoretical backdrop for this study. The central focus of this study is the recontextualization of a textbook when incorporated into teachers' classroom practice. This research focus was elaborated by two further questions:

- What is the nature of the pedagogy privileged in *Mfa7* LAB and associated TRB?
- How do teachers in Grade 7 mathematics classrooms use this textbook?

The summary of the dissertation which follows outlines the research process, research design, analysis of the textbook and teachers' classroom practice when using the textbook, all of which were undertaken to address the research question posed by this thesis.

Chapter 1 described a literature review that served to locate the thesis in a body of research on textbooks. This review focused on literature that covered the availability of textbooks, evaluation and selection of textbooks, analysis of textbooks and the use of textbooks by learners and teachers in classrooms. No study in the literature reviewed, focused on the nature of the recontextualization of a textbook when used by teachers in classrooms and no other study besides that of Mulcahy (1995) analysed a textbook as well as its use in classrooms.

Furthermore, the studies of Czerniewicz et al (2000) and Adler et al (2001)) show that textbook use is a contentious issue within the context of the current curriculum reform in South Africa. Textbooks are either viewed as an important resources for teachers or are negatively associated with 'traditional textbook-centred' teaching practices which potentially undermine the learner-centred pedagogy of C2005. The ambiguity surrounding textbook use is extended to a lack of clarity around who is responsible for producing Learning Support Materials (LSMs). The notion of the teacher, as curriculum designer capable of producing teaching-learning materials, is prevalent within the discourse of C2005. Czerniewicz et al (2000) and Adler et al (2001) question whether teachers have the necessary skills, resources and time to produce LSMs. My study contributes to this debate in that it sets out to ascertain how textbooks are used in teachers' classrooms.

Chapter 2 focused on the production of an analytic framework for the description of the recontextualizing of pedagogic practices inscribed within *Mfa7* LAB to Grade 7 mathematics teachers' classroom practice. This analytical framework is based on Ensor's (1999) model of recontextualization, which is an adaptation of Dowling's Social Activity theory. The model used in my study developed by working inductively and deductively with my data and Ensor's (1999) model.

My study is concerned with school mathematics as a social activity which specialises social actors (teachers and learners) and regulates what each appropriately can do. I distinguished between school mathematics in *general* and in *particular*. The particular instantiations of school mathematics, which the study focused on, were school mathematics as articulated in the textbook *Mfa7* LAB and school mathematics as realised in particular teachers' classrooms. Texts produced within these two instantiations of school mathematics were subjected to analysis which formed the central focus of Chapters 4, 5 and 6. In particular, I considered the textbook as a pedagogic text for learners and in conjunction with the associated teacher's guide as potential pedagogic texts for teachers.

Social activities comprise positions (social actors) and practices. The positions within school mathematics include transmitter, acquirer and objectified positions. I discussed a range of acquirer positions: *apprentice*, *dependent, initiate* and *novice* positions. The practices of school mathematics include school mathematics content and a privileged mode of learning and teaching mathematics.

School mathematics content exhibits high discursive saturation and can therefore to a large extent be realised in language. A textbook therefore has the potential of making the principles of school mathematics content available to learners and teachers. The textbook's privileged pedagogy, however, is a hybrid practice of discursive and tacit aspects, and as such exhibits discursive saturation along a range of DS+ to DS-. Because the privileged pedagogy cannot be fully realised in language, it cannot be communicated completely via a textbook. Aspects of the textbook's privileged pedagogy need to be modelled in the site of practice, the classroom.

Teachers use textbooks in a range of ways. I argued that a teacher either affiliates with the practices of the textbook and attempts to implement the practices of the textbook or the teacher objectifies the practices of the textbook and acts selectively on it, subordinating the textbook's practices to their own practices. Chapters 5 and 6 focussed on an analysis of teacher's use of the textbook *Mfa7* LAB.

Chapter 3 described the main research project on the textbook *Maths for all* Grade 7 LAB and positioned this thesis within the main research project. In addition, this chapter outlined the research design, the data collected and instruments used and the context of this study.

Chapter 4 considered an analysis of a chapter (*Measurement*) from the textbook, *Maths for all* Grade 7 LAB. This analysis focused on the mathematics knowledge made available to learners and teachers as well as the privileged mode of teaching and learning mathematics, the identity of teachers and learners and the relationship between them that it set forth.

Chapter 5 and 6 considered the use of the textbook, *Mfa7* LAB by Grade 7 mathematics teachers. The analysis focused on video-recorded lessons, two interviews and learner notebooks, in order to describe the potential recontextualization of the textbook *Mfa7* LAB when used by teachers in classrooms. The analysis set out the teachers' preferred mode of teaching, the mode of teaching employed while using *Mfa7* LAB and the teachers' construction of their classroom contexts, learners and mathematics. These chapters also focused on how teachers used *Mfa7* LAB in designing the teaching of measurement.

7.3 Research findings

7.3.1 Analysis of textbook

Mfa7 LAB employs a number of pedagogic strategies to achieve an inductive approach to the teaching and learning of mathematics. The textbook uses activities for exploring mathematics, summaries in the form of bullet points to defer the explicit statement of mathematical knowledge, and careful sequencing of activities and bullet points. The textbook constructs the ideal learner as autonomous and capable of discovering mathematical knowledge through practical, exploratory activities. The ideal teacher is constructed as a facilitator who facilitates discussion with learners to ensure that the learning and teaching of mathematics is achieved inductively.

The learning context of the ideal classroom is portrayed as one in which learner-learner interaction is encouraged and the framing between learner and teacher is weakened. The ideal teacher and ideal learner are addressed as apprentices to the privileged practices of the textbook but as the analysis reveals, teachers and learners are positioned as *novices* since mathematics and the privileged pedagogy is only partially made available to them.

Mathematical knowledge is not always made explicit in the text. Conclusions to certain activities are stated in the form of bullet points at the end of an activity. I have argued that this textbook cannot be used effectively by learners independently of a teacher and can only apprentice learners into mathematics through the intervention of a teacher. The textbook consequently relies on the mediation of a teacher to effect mathematical closure to the exploratory tasks and assumes that teachers have a sufficiently strong foundation in mathematics to be able to close the gap effectively for learners.

The logic of the sequencing of the text and linked activities are not made explicit in the textbook. It is assumed that teachers understand the logic of the inductive pedagogy embodied there and that teachers will follow the sequence of the text and use the textbook as it is intended. The textbook therefore relies on teachers' pedagogic competence in using an inductive learner-centred pedagogy to achieve apprenticeship of learners into mathematics.

As I have suggested, a textbook cannot fully communicate the tacit aspects of classroom organisation, mathematics teaching and learning and the expected behaviour of teachers and learners, since these practices exhibit low discursive saturation. Such tacitly regulated practices are best achieved through modelling in the site of practice through for example, classroom-based INSET. The textbook therefore has limited potential to act as a pedagogic text on its own for learners or teachers. This finding supports the conclusions reached by Czerniewicz et al (2000):

> From all accounts, it appears that material inputs such as textbooks and other LSMs cannot on their own, improve teaching; they must be accompanied by teacher development. (Czerniewicz et al, 2000: 43)

7.3.2 Analysis of teachers' classroom practice

The analysis of the textbook provided a basis from which to evaluate teachers' use of the textbook in actual classrooms. All the teachers in this study used textbooks to structure their teaching of mathematical topics although there were variations in the extent of use of the textbook, *Mfa7* LAB.

Mrs Tyandela and Mrs Nkosi affiliated with the textbook's practices, basing their teaching of measurement on *Mfa7.4* LAB exclusively and attempting to implement the practices of the textbook. Mr. Faku and Mr. Mafilika objectified the textbook's practices, used *Mfa7.4* LAB selectively in the teaching of measurement and thereby used *Mfa7.4* LAB as a resource of limited range.

Mrs. Tyandela who had 14 years of teaching experience, a long history of INSET, and who participated as a leader teacher in an INSET project at the time of the research, identified strongly with the practices of the textbook as it corresponded closely to her preferred style of teaching. She demonstrated that she was capable of successfully implementing the practices of the textbook although her close following of the tasks in the textbook negatively affected the pacing of her teaching.

Mrs. Nkosi had 5 years of teaching experience, was teaching mathematics at Grade 7 level for the first time at the time of the research project and had limited exposure to INSET. She attempted to implement the practices of the textbook, but these differed considerably from her preferred deductive pedagogy which emphasised the learning of procedures. She used *Mfa7* LAB since it was the only resource that both she and her learners had access to, and it provided the curriculum guidance that she required. The video-recorded lesson and learner notebooks of Mrs. Nkosi showed that the conflict between the inductive pedagogy of the textbook and Mrs Nkosi's preferred deductive style tended to fragment and reduce the mathematical complexity of the tasks presented to learners, and produced a disjointed overall design of the teaching of measurement.

Mr Faku and Mr Mafilika had 11 and 10 years teaching experience respectively and had a long history of INSET. Mr Mafilika was involved in an INSET programme at the time of the research project. Both teachers, who preferred teaching mathematics deductively by starting with worked examples and then providing learners with practice exercises to consolidate the learning of procedures, did not affiliate with the practices *Mfa7.4* LAB. Both teachers drew selectively on the textbook with Mr Faku using the textbook to a greater extent than Mr Mafilika did. Both teachers' selective use of the textbook fragmented and reduced the mathematical complexity of the tasks recruited from *Mfa7.4* LAB. However, Mr. Faku unlike Mrs. Nkosi subordinated the textbook to his own practice and consequently was able to produce a coherent overall design of the teaching of measurement. Mr Mafilika, who only used the textbook during the video recording, produced a lesson which resonated with the conflict experienced by Mrs. Nkosi. However, Mr. Mafilika was able to maintain overall coherence of the teaching of measurement by largely ignoring *Mfa7* LAB as a teaching resource.

Most teachers in my study preferred a deductive style of teaching which differed from the inductive pedagogy of the textbook and most used the textbook selectively as a resource to constitute their teaching practice. I have argued that selective use of textbooks, such as *Mfa7* LAB, in which mathematical knowledge is partially embedded, exacerbates the fragmentation and reduction in complexity of the intended mathematical knowledge. My study illustrates that most teachers had difficulty in understanding the logic of the inductive pedagogy textbook and consequently had difficulty in implementing the textbook in the classroom. This concurs with the findings of Czerniewicz et al (2000: 43) who report that 'local evaluations reveal that teachers do not necessarily share the vision of materials writers nor share their conceptual goals'. The findings of my study consequently have implications for the use of textbooks or materials as the primary means of transforming classroom practice for the effective implementation of C2005. As stated before, teacher development needs to accompany the distribution of textbooks and other learning materials.

7.4 Limitations and achievements of the study

Due to the limited scope of a study of this kind, the analysis of textbook use focused on four teachers from four schools that are largely similar to each other. The study is therefore small scale and limited to urban, ex-DET schools. It does not contain a range of schools to reflect different contexts or a wide demographic range. The sample was drawn from the sample of experimental teachers of the main research project and the data set was adequate to support the claims of the thesis. My study serves as a basis for further investigation of the remaining teachers involved in the main research project.

An achievement of the thesis is the development of a theoretical model which enables analysis of the recontextualization of a textbook when inserted into teachers' classroom practice. The model has been used for a specific mathematics textbook but can be employed for research based on other mathematics textbooks or textbooks from other disciplines. The potential for the extension of the model points to the generalisability of the thesis.

Another achievement of the study is the research design which combines analysis of a textbook as well as the use of a textbook in classroom settings. Only one study from the literature reviewed, namely Mulcahy (1995) combined textual analysis with classroom-based research. Many studies (Dowling, 1998; Press, 1999), which focus on the analysis of textbooks, have highlighted the need for research on the use of textbooks in classrooms. This study thus contributes to research on textbooks and addresses Gilbert's (1989) concern that analyses of texts tend to be removed from their context of use.

7.5 Potential for further research

Mfa7 LAB is primarily a pedagogic text for learners. As such it is concerned with the transmission and acquisition of mathematics. A natural question arises - 'do the practices inscribed into the textbook promote learners' access into mathematics?' This study can be extended to explore the relationship between the textbook and learner achievement in mathematics. This is one of the foci of the main research project which assessed learner achievement through comparing pre-and post-test results. However, Collins (2001) argues that the analysis of student written productions such as notebooks is an equally valid form of determining learners' achievement as formal testing (Collins, 2001: 121). In particular, the learner notebooks collected for this study could be analysed to determine the nature of learners' mathematical knowledge. However, as Collins (2001) points out, this would need to be supported by interviews with learners and classroom observation of learners engaging with the textbook.

The analysis of teachers' use of *Mfa7* LAB in their classroom in this study shows that two of the teachers used the textbook exclusively while the other two selected from the practices of the textbook. This division was coincidentally split along gender lines. The female teachers in the sample used the textbook exclusively and attempted to implement the practices of the textbook. The male teachers did not identify with the textbook's practices and selectively recruited from the textbook to constitute their own practices. As the sample for this study is small, there is insufficient evidence to draw any conclusions about gender differences in the use of textbooks. An in-depth analysis of the influence of gender would require a larger sample of teachers. This question can be extended to the main research project with which this study is associated.

A potential area for further research is the relationship between the language of the textbook and learners' access to mathematics. *Mfa7* LAB is particularly 'text heavy' which poses questions around how second language learners engage with such texts. In particular, the way in which teachers tended to restrict learners' interaction with text is a concern raised by this study. This concern confirms the findings of Sosniak & Perlman (1990) who found that students rarely read mathematics texts independently and endorses the conclusions reached by Czerniewicz et al (2000: 43) that learners limited reading and interpretation of texts 'sets patterns of rote learning and dependency'.

7.6 Recommendations

Although the task of thesis was to examine how textbooks were used in classrooms, the study has raised many issues around pedagogy. The production of the analysis and reflection on this thesis has led to a number of insights on textbook design, teacher development and curriculum and policy development. Some of the recommendations are outlined below.

7.6.1 Textbook design

Mfa7 LAB encourages an inductive exploratory approach to teaching and learning mathematics. The pedagogic strategies used by the *Mfa7* LAB to achieve this inductive approach have been discussed in this thesis. A consequence of an inductive exploratory pedagogy is that it opens up the space for multiple interpretations of the text. This is not to say that multiple interpretations are avoided in deductive texts. Textbooks advocating a deductive pedagogy however, clearly state definitions of mathematical concepts and provide worked examples. In this way, the learning outcomes of the text are made explicit. Textbooks that embody an inductive pedagogy need to be explicit about the mathematical knowledge that learners are meant to acquire through the use of these texts. Summaries of the key mathematical ideas of a chapter need be presented so that the aim of each chapter becomes obvious to learners and teachers. Summaries of key ideas would also be useful to learners when they need to revise topics for tests or examinations or if they need quick references to mathematical concepts and information such as formulae and definitions which might be required for another topic.

The rationale for the sequencing of activities in textbooks in order to develop particular mathematical concepts needs to be stated explicitly in teacher's guides. In addition, teachers need to be made aware that selecting one activity from a chapter could potentially lead to a different outcome from that intended by the authors and could possibly fragment and reduce the complexity of the intended mathematical outcomes of the task.

As discussed in Chapter 4 of this thesis, *Mfa7.4* LAB uses three activities to deal with length and four activities to deal with perimeter and area. The pacing of mathematical knowledge is very slow – a consequence in part of an inductive, exploratory approach. The teachers' slow pacing emerged from the analysis of the video-recorded lessons. An analysis of the notebooks of the teachers in my study revealed that teachers had covered very little curriculum content from January to end of September 2000. This implies that generally the pace of teaching and learning at these schools is extremely slow. The notebooks revealed that all four teachers' covered limited amounts of the mathematics curriculum.

Poor coverage of the curriculum could be due to a number of factors. For example, poor management of schools, poor management of the curriculum or other contextual issues, such as whether schools start and end the day on time or whether time is effectively used for curricular activities (see Hoadley, 1999), could negatively impact on the pacing of teaching at the schools. The lack of curriculum guidance on selection and sequencing of mathematics topics could also contribute to the slow pacing and consequently to the limited curriculum coverage. These issues fall outside the ambit of this thesis. However, poor coverage of the curriculum was evident amongst all the teachers and could be one of the major factors contributing to poor learner performance in tests and examinations. This issue is explored by the main research project.

However, I feel that textbook authors need to pay attention to the issue of pacing. For example, simply inserting a statement such as 'discuss in class' or 'discuss with a friend' as an instruction in a textbook could result in a teacher spending excessive time on a task which does not provide access to significant mathematical understanding. Instructions such as 'discuss in class' are intended to signal a particular form of learning mathematics but need to be used with care.

7.6.2 Curriculum and policy development

Czerniewicz (2000) et al and Adler et al (2001) point out that the role of textbooks and responsibility for developing LSMS are not clearly defined in policy documents. My study as well as that of Adler et al (2001) conclude that teachers are using textbooks in their classrooms and that textbooks are an important resource for teachers. Textbooks are particularly important in the context of C2005, which has not provided teachers with sufficient guidance on selection, and sequencing of mathematical topics. The Revised National Curriculum Statement (2001) which is currently being finalised has to some extent attempted to provide clearer guidelines of what learners at each grade level are expected to know. Interviews with the teachers in my study and analysis of their learner notebooks revealed that teachers were unclear as to what constituted a Grade 7 mathematics curriculum. They turned to textbooks for this guidance. There appears to be an expectation in the Revised National Curriculum Statement (2001) that textbooks would to a large extent interpret the curriculum for teachers. This in turn highlights the need for the development of policy which clarifies the role of textbooks in the curriculum.

Even though textbooks were provided by the research project the learners in my study were not provided with access to mathematics textbooks. This contrasts with the findings of Adler et al (2001) in their research on textbook use in classrooms. Learners' lack of access to textbooks has to be viewed within a history of textbook use in classrooms and contexts in which learners generally do not have textbooks. My study demonstrates that teachers do not easily manage to break with existing practices. This strengthens the need for the provincial government to develop a coherent policy on textbooks and for INSET providers and the provincial education departments to support teachers in developing classroom practices which include learners' engagement with textbooks in general and in particular.

The findings of this study are significant in the light of the implementation of C2005 which promotes an inductive approach to teaching and learning. This study shows that teachers who have not been apprenticed into an inductive pedagogy find it extremely difficult to implement. In addition, this study raises the question as to whether an inductive learner-centred pedagogy is the most effective pedagogy given teachers' poor mathematical background and the contexts in which they teach. An inductive pedagogy can be time-consuming and in contexts where teachers are battling to manage time effectively, the ineffective use of an inductive pedagogy merely compounds the problem. It could be argued that a deductive pedagogy, which foregrounds the learning of principles, might be more effective than the ineffective use of an inductive pedagogy.

7.6.3 Teacher development

Textbooks do not function separately in a classroom but form a component of the teacher-textbook-learner triad. Therefore effective functioning of the textbook is related to how it is used in classrooms by teachers and learners. Although the pedagogic practices of a textbook may be sound, teachers need to develop the skills required to use the textbook effectively. Teacher development, both PRESET and INSET, need to focus on developing teachers' skills in using textbooks in classrooms as well as their content knowledge and teaching practices.

Teacher development needs to focus attention on evaluating textbooks, which should not only involve assessing whether a textbook is 'good' or 'bad' but should involve analysing the content of the textbook in order to uncover the pedagogic pathway constructed by the text. Teachers need to recognise the intended mathematical outcomes of the text and how different concepts are sequenced in the text to produce a pedagogic pathway. Content analyses of textbooks however, require a sound foundation in mathematical content knowledge.

Too often PRESET and INSET programmes concentrate on discrete activities or tasks to exemplify a particular orientation to teaching mathematics or a particular approach to teaching a topic in mathematics. Very little attention is placed on locating discrete activities or learning tasks within a learning framework. PRESET and INSET programmes can often be described as episodic in that they do not concentrate sufficiently on developing systematic learning programmes or analysing systematic learning programmes such as textbooks. Teachers need to be enskilled in developing a coherent pedagogic pathway, a skill required particularly when using textbooks selectively.

Furthermore, teacher development courses need to focus teachers' attention on reading mathematics textbooks themselves. Teachers need be encouraged to develop reading skills of their learners not only through engagement with reading schemes and story books but also through engaging learners in reading textbooks. Reading texts after all does not only belong in a language classroom. Learners should be encouraged to read and interpret mathematical text independently. These are crucial skills required if learners are to access the discourse of school mathematics.

This thesis concludes that it is imperative to dispel the notion that 'good teachers do not use textbooks' (Ball & Feiman-Neimser,1988: 402) within the discourse of education at all levels of the system since textbooks can play an important supplementary role in the transformation of teaching and learning.

7.7 Concluding words

The attempt in this study to produce a coherent analysis will, it is hoped, make a contribution to research on textbooks. A further aspiration of this study is its potential contribution to textbook design, teacher development, curriculum and policy development and ultimately to the teaching and learning of mathematics in classrooms.

APPENDICES

Appendix 3.1: Teacher Questionnaire 1

Teacher's full name:	
School:	Date: ....

TEACHER QUESTIONNAIRE NO 1:

PRELIMINARY SURVEY OF GRADE 7 MATHEMATICS CURRICULUM INFORMATION FOR SECOND TERM 2000

Thank you for agreeing to participate our research project which aims to investigate the quality of a mathematics textbook at grade 7 level. This questionnaire asks you to provide information on:

- the curriculum documents you will be using to guide your ***grade 7 (std 5) mathematics*** programme in 2000;
- whether you agree to cover the curriculum topics we would like you to teach your grade 7 mathematics class ***during the second term of 2000***;
- the mathematics textbooks/curricular material you intend using the most in teaching mathematics to your grade 7 class in 2000;
- in-service mathematics courses you have attended in the last five years; and
- the language/s of instruction used in your grade 7 mathematics classes.

Your co-operation in completing this questionnaire as accurately as possible is greatly appreciated.

Dr Paula Ensor
Jaamiah Galant
Cheryl Reeves

SECTION A

CURRICULUM DOCUMENTS USED TO GUIDE YOUR GRADE 7 MATHEMATICS PROGRAMME IN 2000

Tick one box in each row

1. Which of the following official curriculum documents will you use to guide your ***grade 7 mathematics*** programme in 2000?

a) Curriculum 2005	Yes 1	No 2
b) Interim syllabus for the Western Cape	Yes 1	No 2
c) Departmental curriculum guides......................	Yes 1	No 2
d) Your school's own written statement of curriculum content . . .	Yes 1	No 2

e) Other, specify ....

....

VERSION ONE FOR CONTROL TEACHERS

SECTION B

MATHEMATICS TOPICS

2. The two mathematics topics that we would like you to cover in your grade 7 maths lessons in the second term of 2000 are provided below. Each topic is illustrated by a short list of subtopics. Please indicate if you agree to cover these topics in the second term and indicate the estimated number of lessons in which you anticipate the topic/subtopics will be covered. Four choices are provided for each topic: 1 - 5 lessons, 6 - 10 lessons; 11 – 15 lessons and more than (>) 15 lessons.

TOPIC	*Agree to teach in second term*		*Estimated number of lessons*			
	Yes 1	*No* 2	*1-5 lessons* 3	*6-10 lessons* 4	*11-15 lessons* 5	*> 15 lessons* 6
a) Measurement						
1. Ideas of measurement and units						
2. Standard units…………………… (centimetres & millimetres)						
3. Length …………………………						
4. Perimeter & area……………… (of triangles, quadrilateral, circles and other two dimensional shapes)						
b) Decimals and percentage						
1. Meaning, representation and use of decimal fractions……….						
2. Relationships between common and decimal fractions…………..						
3. Converting between fractions and decimal form……………….						

4. Concepts of percentages..........						
5. Computations and percentage...						

VERSION TWO FOR EXPERIMENTAL TEACHERS

SECTION B

MATHEMATICS TOPICS

2. The two mathematics topics that we would like you to cover in your grade 7 maths lessons in the second term of 2000 are provided below. We have provided the pages of the Learner's Activity Book, *'Maths for all'*, that we would like you to cover with your classes. Please indicate if you agree to cover these topics in the second term. Look at these sections of the learner's book and indicate the estimated number of lessons in which you anticipate the topic/pages will take to be covered. Four choices are provided for each topic: 1 - 5 lessons, 6 - 10 lessons; 11 – 15 lessons and more than (>) 15 lessons.

TOPIC	*Agree to teach in second term*		Estimated number of lessons			
	Yes 1	*No* 2	*1-5 lessons* 3	*6-10 lessons* 4	*11-15 lessons* 5	*> 15 lessons* 6
a) Measurement Pages 65 –78						
b) Decimals and percentage Pages 123 - 138						

SECTION C

TEXTBOOKS/CURRICULAR MATERIAL YOU INTEND USING THE MOST IN TEACHING MATHEMATICS TO YOUR GRADE 7 CLASS IN 2000

3. Do you intend to use textbooks or other curricular material in teaching mathematics to your grade 7 class in the second term of 2000?

tick one box

Yes	1	No	2	Unsure	3

4. If yes, write in the title, author/publisher etc. of the textbook/s/material you will use the most.

Title: ....

Author (or publisher): ....

Year: .... Other: ....

Title: ....

Author (or publisher): ....

Year: .... Other: ....

Title: ....

Author (or publisher): ....

Year: .... Other: ....

Title: ....

Author (or publisher): ....

Year: .... Other: ....

SECTION D

IN-SERVICE EDUCATION (INSET) IN MATHEMATICS

5. Have you attended any in-service courses in *Mathematics* in the last 5 years? . . . . | *Yes* | 1 | | *No* | 2 |

6. If yes, tick the INSET provider/s and write the year/s in which you attended the course/s.

A. INSET Provider	**Tick**				**B. Year**
	Yes	1	No	2	**attended**
a) MEP (UCT)					
b) TLRC (UCT)					
c) Primary Maths Project (Goldfields) .					
d) TIP (UWC)					
e) POLP					
f) Primary Primset					
g) Thousand Schools					
h) Malati Project					
i) Rumeus					
j) Departmental courses					
k) Master Maths					

Any other Maths INSET courses not listed above, specify:

....

SECTION E

LANGUAGE OF INSTRUCTION

7. What language/s of instruction will you use for your grade 7 mathematics lessons in 2000?

....

Appendix 3.2: Teacher questionnaire 2

Teacher: ....

School: ....

Date: .... Fieldworker's name: ....

Note to fieldworker: This questionnaire is for the grade 7 mathematics teacher to complete. Please ensure that all the details on the forms are as accurate as possible and that details on the form are comprehensive. Offer to work through the questionnaire with the teacher.

TEACHER QUESTIONNAIRE NO 2:

Thank you for agreeing to participate our educational research project that aims to investigate the quality of a mathematics textbook at the grade 7 (std 5) level. This questionnaire asks you as a grade 7 mathematics teacher to provide information about your

- academic and professional background
- classroom practices, especially the use of textbooks
- attitudes towards teaching mathematics
- grade 7 mathematics class

It is important that you answer each question as carefully as possible so that the information provided reflects your situation as accurately as possible.

When you have completed the questionnaire, please keep it for collection by our fieldworker.

Your co-operation in completing this questionnaire is greatly appreciated.

Assoc. Prof Paula Ensor , Jaamiah Galant, Cheryl Reeves

Adapted from IEA (TIMSS) Doc.ref: ICC879NRC419.
School Questionnaire: Population 1© 1994.

1. How old are you? *tick one box only*

a)	under 25	1
b)	25 – 29	2
c)	30 - 39	3
d)	40 – 49	4
e)	50 – 59	5
f)	60 or more	6

2. Are you female or male? *tick one box only*

a)	female	1
b)	male	2

3. What is your primary / first language? *tick one box only*

a)	Xhosa	1
b)	Afrikaans	2
c)	English	3
d)	Sotho	4
e)	Setswana	5
f)	Zulu	6
g)	Ndebele	7
h)	Sepedi	8
i)	Tsonga	9
j)	Shangaan	10
k)	Other, specify:	11

4. What is the highest level of formal education you have completed? *tick one box only*

a)	Std 8	1
b)	Std 8 + 1 year teaching training	2
c)	Std 8 + 2 year teaching training	3
d)	Matric	4

e)	Std 8 + 1 / 2 year teacher training + Matric	5
f)	M + 1 year teacher training	6
g)	M + 2 year teacher training	7
h)	M + 3 year teacher training	8
i)	M + 4/5 year teacher training, e.g. FDE	9
j)	B. Degree, e.g. B.A., B.Sc + no teacher training	10
k)	B. Degree, e.g. B.A., B.Sc + teacher training	11
l)	Post graduate degree, e.g. B.Ed/B.Hons + no teacher training	12
m)	Post graduate degree, e.g. B.Ed/B.Hons + teacher training	13
n)	Masters + no teacher training	14
o)	Masters + teacher training	15

5. What was the year in which you achieved your last formal academic / **teaching** qualification?. . . . .

Write the year only

....

6. By the end of this school year, how many years will you have been teaching altogether? . . . .

Please round to nearest whole number

....

7. At which of these grade levels have you taught in the past 5 years?

Tick one box only in each row

		Yes 1	No 2
a)	Pre-school		
b)	Grade 1		
c)	Grade 2		
d)	Grade 3 / Std 1		
e)	Grade 4 / Std 2		
f)	Grade 5 / Std 3		
g)	Grade 6 / Std 4		
h)	Grade 7 / Std 5		
i)	Grade 8 / Std 6		
j)	Grade 9 / Std 7		

k) Grade 10 / Std 8 . . . .

l) Grade 11 / Std 9 . . . .

m) Grade 12 / Std 10 . . . .

8. Approximately how many hours per week do you normally spend on each of the following activities?

Tick one box only in each row

	None (1)	Less than 1 hr (2)	1-2 hrs (3)	3-4 hrs (4)	More than 4 hours (5)
a) Preparing/marking **maths** tests/ assessment					
b) Reading and marking learners maths class work or homework					
c) Planning maths lessons					
d) Giving extra mathematics lessons outside classroom time (breaks etc)					
e) Meeting with parents / care-givers about learners' mathematics achievement					
f) Professional development activities in mathematics, e.g. in-service mathematics teacher training.					
g) Keeping records of learners' mathematics marks or assessment up to date					
h) Administrative tasks for maths teaching e.g. photocopying mathematics worksheets etc.					

9. About how often do you have meetings with other mathematics teachers at your school to discuss and plan curriculum or teaching approaches?

Tick one box only

a) never 1

b) once or twice per year 2

c) every second month 3

d) once a month 4

e) once a week 5

f) 2/3 times a week....................................... 6

g) almost every day 7

10. How many learners are there in the grade 7 mathematics class who are being tested by our research project? .... *Write a number* [ ]

11. Estimate the number of learners in this grade 7 class who have *Please write a number*

a) high achievement levels in maths ....

b) middle achievement levels in maths ....

c) low achievement levels in maths ....

TOTAL ....

12. Is mathematics taught mainly as a separate subject (i.e. not integrated with other subjects) to grade 7 classes? .... *Tick one box*

Yes	1	No	2

13. Estimate how many hours per week you spend teaching Mathematics to this class .... *Please write a number* ....

14. In your view, to what extent do the following factors affect your grade 7 mathematics teaching?

	not at all	1	a little	2	quite a lot	3	a great deal	4
a) Learners lack of mathematical background knowledge and skills and other competencies (such as adequate reading levels) for grade 7....................								
b) You consider your own subject knowledge of mathematics is poor or inadequate for teaching grade 7 mathematics								

c) lack of support for yourself as a teacher from maths courses, workshops etc. from in-service organisations and/or the education

department				
d) shortage of good textbooks and/or other classroom material				
e) unclear or inadequate guidance from curriculum documents				
f) lack of support and guidance for mathematics teaching from Head of Departments				
g) frequent interruptions and limitations in teaching time through poor management at the school				
g) frequent interruptions and limitations in teaching time through poor management at the school				
h) high learner/teacher ratio (more than 35:1)				

15. How many of your grade 7 learners have access to calculators during mathematics lessons?

Tick one box only

a) almost all		1
b) about three quarters		2
c) about half		3
d) about one quarter		4
e) none		5

16. How often do learners in your grade 7 classes use calculators for the following activities?

Tick one box for each row

	Almost every day	1	once or twice a week	2	once or twice a month	3	never or hardly ever	4
a) checking answers								
b) tests or examinations								
c) routine calculations								
d) solving complex problems								

e) exploring number concepts . . . .

17. Do you assign mathematics homework to the grade 7 class which will be tested by our research project? . . . .

Yes	1	No	2

18. If yes, how often do you usually assign mathematics homework to this class?

Tick one box only

a) never		1
b) less than once a week		2
c) once or twice a week		3
d) 3 or 4 times a week		4
e) every day		5

19. If learners are assigned **WRITTEN** mathematics homework , how often do you do the following?

Tick one box

	Never 1	rarely 2	some-times 3	always 4
a) record whether or not the homework was completed				
b) collect, correct and keep homework				
c) collect, correct homework and return to learners				
d) give feedback on homework to whole class .				
e) have learners correct their own homework in class				
f) have learners exchange homework and correct them in class				
g) use it as a basis for class discussion				
h) use it to contribute towards learners' marks .				

20. Do you ever give your grade 7 mathematics class **WRITTEN** Mathematics tests? . . . .

Yes	1	No	2

21. If yes, how often?

Tick one box

a) at least once per week	1
b) at least once per month	2
c) at least once per term	3
d) at least once per year	4

22. Do you provide extra maths lessons for grade 7 learners? .....

Yes	1	No	2

23. If yes, how is this organised?

Tick one box

	Yes 1	No 2
a) learners receive extra lessons before or after school		
b) learners receive help during break?		
c) other, specify:		

24. Please rank the following from '1' (most important) to '5' (least important).

Good mathematics students ...

a) are hard-working and obedient	
b) think creatively and are good at problem-solving	
c) are able to provide reasons to support their solutions	
d) remember mathematical facts and procedures taught in class	
e) understand how mathematics is used in the real world	

25. Textbooks are important for maths Teaching because they help me as a Teacher to ...

Tick one box in each row

	Strongly agree 1	agree 2	dis-agree 3	strongly dis-agree 4
a) plan daily lessons.				
b) select and choose exercises and activities for classwork				
c) provide progressively difficult examples/ that help learners develop skills and Understanding				
d) order the topics to be covered over the year				
e) provide ideas about how I can approach different topics				

f) keep learners busy . . . .

g) provide exercises and activities for homework . . . .

h) provide learners with opportunities to work Independently of me as the teacher . . . .

i) help me clarify mathematical understandings and concepts for myself . . . .

j) Textbooks are not important for mathematics teaching . . . .

26. Curriculum documents (such as a Syllabus or Curriculum 2005) are important because they help you to ...

Tick one box in each row

	strongly agree 1	agree 2	dis-agree 3	strongly dis-agree 4
a) decide which topics to teach in each grade. .				
b) decide how to teach or present particular topics.				
c) plan your daily lessons and select problems and exercises for classwork				
d) decide on assessment and evaluation				
e) Curriculum documents are not important in planning my teaching				

27. Please select the **THREE** MOST IMPORTANT factors in teaching mathematics:

a) teaching learners to remember mathematical facts and procedures . . . .

b) developing deep conceptual understandings . . . .

c) introducing maths ideas through real-life examples . . . .

d) helping learners to use mathematics in real world or practical applications . . . . . .

e) using whole class discussion to 'bring/draw out' learners' understandings or explanations . . . .

f) providing learners with opportunities to work in pairs or small groups . . . .

g) using more than one way of representing a mathematical concepts (picture, concrete material, symbol etc.) when teaching the topic . . . .

h) ensuring that learners get opportunities to work independently on their own . . . .

i) ensuring that learners are enjoying and liking what they are doing . . . .

j) for the teacher to teach the same topic to the whole class at the same time . . . . .

k) ensuring that the class is orderly, quiet and works hard . . . .

l) other factor/s not listed, specify ....

....

....

....

THANK YOU for the thought, time and effort you have put into completing this questionnaire.

Appendix 3.3: School Questionnaire

School: .... Date: ....

Names and status (e.g. principal, deputy principal) of person(s) responsible for completing this questionnaire:

....

Fieldworker's name: ....

Note to fieldworker:
This questionnaire is for the school principal / deputies / HoDs to complete. Fieldworkers must ensure that all the details on the forms are as accurate as possible and that details on the form are comprehensive. For this reason, offer to work through the questionnaire with the principal / deputies / HoDs

SCHOOL QUESTIONNAIRE:

Thank you for agreeing to participate in our educational research project that aims to investigate the quality of a mathematics textbook at the grade 7 (std 5) level. This questionnaire asks school principals / deputies / department heads to provide information on your school.

It is important that you answer each question as carefully as possible so that the information provided reflects the situation at your school accurately. Some questions may require you to spend time looking up information in your school records.

When you have completed the questionnaire, please keep it for collection by our fieldworker. Your co-operation in completing this questionnaire as accurately as possible is greatly appreciated.

Assoc. Prof Paula Ensor, Jaamiah Galant, Cheryl Reeves & Donald Katz

---

Adapted from IEA (TIMSS) Doc.ref: ICC882/NRC419.

1. Where is your school located?	*tick one box*	
In a formal 'township'		1
In an informal settlement area		2
2. Which of the following levels are found in your school?	*tick relevant boxes*	
a) Grades 1 - 4....................................		1
b) Grades 5 - 7....................................		2
c) Other Grades, specify....................................		3
3. What is/are the language(s) of instruction at the school?	*tick relevant boxes*	
a) Xhosa		1
b) Afrikaans		2
c) English		3
d) S. Sotho		4
e) N. Sotho		5
f) Setswana		6
g) Zulu		7
h) Ndebele		8
i) Sepedi		9
j) Tsonga		10
k) Shangaan		11
l) Other, specify:		12
4. What is/are the primary/first language(s) of the majority of learners at the school?	*tick relevant boxes*	
a) Xhosa		1
b) Afrikaans....................................		2
c) English		3
d) S. Sotho		4
e) N. Sotho		5
f) Setswana		6

g) Zulu 7

h) Ndebele 8

i) Sepedi 9

j) Tsonga 10

k) Shangaan 11

l) Other, specify: 12

5. What is/are the primary/first language(s) of minority groups of learners at the school?

tick relevant boxes

a) Xhosa 1

b) Afrikaans 2

c) English 3

d) S. Sotho 4

e) N. Sotho 5

f) Setswana 6

g) Zulu 7

h) Ndebele 8

i) Sepedi 9

j) Tsonga 10

k) Shangaan 11

l) Other, specify: 12

6. How many of the following are on full-time staff at the school?

Number

a) Principals ....

b) Deputy principals ....

c) Heads of Department ....

d) Classroom teachers ....

e) Cleaners, gardeners, guards etc. ....

f) Administrative staff (secretaries etc.). ....

Total ______

7. How long has the present school principal been **principal** at the school?

tick one box

a) Less than 1 year		1
b) 1 – 2 years		2
c) 3 – 4 years..		3
d) 5 or more years		4

8. How much influence do each of the following have in determining the **grade 7** mathematics curriculum that is taught at your school?

tick one box in each line

	none 1	a little 2	some 3	a lot 4
a) National Department of Education				
b) National Subject Associations (eg AMESA). .				
c) Provincial Education Department				
d) School governing body				
e) Principal				
f) Teachers (collectively for whole school)				
g) Teachers (of same subject) as a group				
h) Grade 7 teacher as an individual				
i) Parents				
j) Learners' needs....................				
k) Textbooks..................				
l) External examinations/standardised tests ...				
m) Teacher unions/organisations				

9. In your school, how many computers are:

Write a number for each.
Write 0 (zero) if none

a) available for general use by learners?	....
b) used by teachers for administrative purposes?	....
c) used by teachers during teaching time?	....
d) used by learners for educational purposes?	....

e) used by office staff for record keeping . . . .

10. Is your school's capacity to provide instruction affected by a shortage or inadequacy of any of the following?

Tick one box in each line

	None 1	a little 2	some 3	a lot 4
a) Electricity				
b) Teachers				
c) Budget for covering running costs and maintenance				
d) Supplies of paper, pencils, notebooks etc. . .				
e) Classrooms				
f) Classroom space/size				
g) Chairs, desks, tables				
h) Textbooks				
i) Calculators for mathematics instruction				
j) Library materials relevant for teaching				
k) Audio-visual resources/equipment for teaching (e.g. overhead projectors)				
l) Facilities for duplicating worksheets, etc. . . .				

11. What is the total school enrolment (number of learners)? . . . .

12. On a typical school day, what number of learners are absent from school for any reason? . . . .

Write a number for each.
Write 0 (zero) if none

13. How many learners are in **grade 7**? . . . .

14. What is the approximate average class size in **grade 7**? . . . .

15. How many **grade 7** classes are there? . . . .

16. About how often does the school administration or staff have to deal with the following behaviours among Learners in the whole school?

tick one box in each line

	daily 1	weekly 2	monthly 3	rarely 4
a) Arriving late at school				
b) Absenteeism				
c) Skipping class				
d) Creating classroom disturbances				
e) Vandalism				
f) Theft				
g) Intimidation or verbal abuse of other learners				
h) Physical threats or injuries to other learners .				
i) Intimidation or verbal abuse of staff				
j) Physical threats or injuries to staff				

17. During the year, do **grade 7** learners write internal examination(s)? . . . . Yes 1 No 2

18. If yes, who is responsible for setting the **grade 7** mathematics examination(s)? . . . . Yes 1 No 2

Tick one box in each line

	Yes 1	No 2
a) Principal		
b) HoD		
c) Standard head		
d) Grade 7 mathematics teachers collectively		
e) Individual grade 7 mathematics teachers		

19.

Write a number

a) How many instructional periods are there in a day? . . . .

b) How many minutes is a typical instructional period? . . . .

20. Roughly how many learners at your school:

Tick one box in each line

none 1	some 2	most 3	all 4

a) come from poverty-stricken backgrounds? . . | | | |

b) come from homes where their parents/main caregivers did not receive more than primary schooling . . . .

c) come from homes which do not have electricity . . . .

d) come from homes which do not have running water . . . .

e) have health or nutrition problems . . . .

21. On what basis are learners admitted to your school?

Tick one box in each line

a) Residence in a particular area	Yes 1	No 2
b) Preference given to learners whose primary language is the same as the majority of learners at the school	Yes 1	No 2
c) Learner's academic performance	Yes 1	No 2
d) Preference given according to date of application.	Yes 1	No 2
e) No criteria.	Yes 1	No 2
f) Other criteria, specify	Yes 1	No 2

22. What are the school fees per year? . . . .

23. How many of the following facilities do you have at your school?

Write a number for each.

a) Classrooms	....
b) Staffrooms	....
c) Offices	....
d) Store rooms	....
e) Halls	....
e) Libraries	....
e) Science/Biology laboratories	....

Appendix 3.4: Classroom Observation schedule

School: ....

Teacher's name: ....

Today's date: .... Venue / Location (e.g classroom/outdoors, etc)...........................

Number of learners actually present at the lesson: .... Number absent:.........

Approximate length of lesson observed: .... minutes

Time lesson begins: .... Time lesson ends: ....

OBSERVATION SCHEDULE

PART ONE: ESTABLISHING THE LESSON CONTEXT

This schedule to be completed by the fieldworker before, while and after observing the lesson. Please tick (✓) or cross (x) relevant blocks and comment where necessary.

The learning environment

1. In the classroom/room, is/are there:

Tick one box in each row

a)	cupboards/storage space?	Yes	1	No	2
b)	usable chalkboards?	Yes	1	No	2
c)	a table for the teacher?	Yes	1	No	2
d)	sufficient seating or desks or writing surface(s) per learner?	Yes	1	No	2
e)	sufficient space for the teacher to organise different activities or seating arrangements?	Yes	1	No	2
f)	adequate lighting?	Yes	1	No	2
g)	adequate ventilation?	Yes	1	No	2
h)	a comfortable temperature?	Yes	1	No	2
i)	noise or outside distraction?	Yes	1	No	2

Comments on physical condition of classroom *(e.g. evidence of care/neglect, e.g. vandalism, cleanliness, etc.)*

....

....

....

....

Classroom organisation

2. Are learners seated: *Tick one box only*

alone at individual desks/tables?	1
in pairs at 2 seater desks/tables?	2
in groups at desks/tables grouped together?	3
other, specify	4

3. Are all/most of the learners seated facing the teacher/front of the classroom? . . . . *Tick one box in each row*

Yes	1	No	2

4. In the course of the lesson, does the teacher: *Tick one box only*

remain in one place?	1
move around the class?	2
both of the above?	3
other, specify?	4

Any other comments you wish to make? ....

....

....

Lesson topic

***5. What is the Maths topic addressed in the lesson (i.e. what is being taught)?* [if the topic is not clear, state this.]**

....

....

6. Does this lesson appear to be: *Tick one box only*

an introductory lesson?	1
a continuation of a previous lesson?	2
the end of a series of lessons?	3
other, specify?	4

Lesson structure, organisation of tasks, time on task	*Sequence of activities*	*Estimated no of minutes*
7. Describe the sequence of the lesson activities and estimate the number of minutes spent on each activity. Ignore activities that are not applicable:		
a) front of class exploratory teaching (explaining, elaborating, etc)......		
b) learners responding to teacher's questions		
c) distribution of textbooks, worksheets/classroom material		
d) distribution of other resources, apparatus, calculators, etc.		
e) teacher issuing simple instructions		
e) learners reading text themselves		
f) teacher reading text with learners following		
g) teacher reading text to learners		
h) organisation of learners into groups/pairs		
i) learners discussing work with each other in pairs/groups		
j) learners working on tasks on their own writing in their notebooks etc.		
k) outside disruptions/interruptions (e.g. intercom announcements, teacher having to leave the room, etc)		
l) other, specify		
8. Does the lesson begin on time?	Yes 1	No 2

Any other comments you wish to make? ....

....

9. How does the teacher pace the lesson in terms of available time?	*Tick one box only*
very efficiently?	1
efficiently?	2
inefficiently?	3

Any other comments you wish to make?: ....

....

....

10 Does the teacher organise tasks/activities so that learners work:	*Tick relevant boxes*
Individually without assistance from the teacher?	1
Individually with assistance from the teacher?	2

Together as a class with the teacher assisting the whole class?	3
Together as a class with learners responding to one another?	4
In pairs or small groups without assistance from the teacher?	5
In pairs or small groups with assistance from the teacher?	6
Other, specify?	7
Teacher does not organise tasks/activities	8

Other comments ....

....

....

....

11. Do learners complete maths tasks / activities in the time allocated? *Tick one box only*

All?	1
Most (at least three quarters of the class)?	2
Some (at least half the class)?	3
Few (less than half the class)?	4

12. Is the time allocated for the completion of tasks/exercises too generous? . Yes 1 No 2

13. Are tasks cut short and never completed (e.g. period ends and work unlikely to be continued in the next lesson)? . . . . Yes 1 No 2

Comments ....

....

....

14. Overall, what percentage of the lesson could be described as:

Productive in terms of teaching and learning?	1
Unproductive in terms of teaching and learning?	2

15. Do learners appear attentive and involved during the lesson? *Tick one box only*

all	1
most (about three quarters)	2
some (about half)	3
few (less than half)	4
none	5
other, specify	6

16. How does the teacher respond to learners who are not participating in the lesson? ....

....

....

....

Organisation and use of textbooks/technology and other material resources

Tick one box in each row

17. Are *Maths for All* learners books used during the lesson?	Yes	1	No	2
18. Is there evidence of the teacher using the *Maths for All* teachers' guide?	Yes	1	No	2
19. Is/are textbooks(s) /other material besides *Maths for All* used?	Yes	1	No	2

20. If yes to 17 & 18 note the details (title, pages, learner's book/teachers' guide used etc) here or try to get a copy of the worksheet and attach it to this observation schedule.

....

....

....

....

21. If yes to 17/18, is there a textbook/worksheet/workbook? *Tick one box only*

for the teacher only?		1
per group of learners?		2
per desk/table?		3
per pairs of learners?		4
per learner..		5

22. If yes to 17/18, do learners take the book/material home?	Yes	1	No	2

23. If the teacher writes activities/exercises on the chalkboard, try to note/write down the activities/work on the board here (continue on the back of this sheet if there is insufficient space here)

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

24. Is use made of other support material/resources/apparatus, e.g. overhead projector, paper, scissors etc.? .... Yes [1] No [2]

If yes, specify: ....

....

25. If teacher demonstrates to the class, does he/she demonstrate to: *Tick one box only*

the whole class?	1
a group of learners at a time?	2
other, specify?	3

26. Are all learners able to see the teacher's demonstrations?........... Yes [1] No [2]

27. Is use made of calculators during the lesson? .... Yes [1] No [2]

28. If yes, do the learners themselves use calculators? .... Yes [1] No [2]

29. If yes, is there a calculator:	*Tick one box only*	
per learner?		1
per pair of learners?		2
per group of learners?		3
other, specify?		4
30. If yes to 27, what do they use the calculators for?	*Tick relevant boxes*	
a) checking answers		1
b) routine calculations		2
c) solving novel problems.		3
d) exploring number concepts		4
e) other, specify?		5
31. Do learners have the necessary writing equipment (pens, paper, etc.) for the lesson?	*Tick one box only*	
all		1
most (at least three quarters of the class)		2
some (at least half the class)		3
few (less than half the class)		4
none		5

32. Do learners have more than one notebook for Mathematics .... Yes 1 No 2

Provide details ....

....

33. Do the learners use their maths notebooks regularly and organise their notes/worksheets and class/homework appropriately? .... Yes 1 No 2

Comments ....

....

34. Is there evidence in the notebooks of work being marked or checked regularly? .... Yes 1 No 2

Comments ....

....

Language(s) of learning and teaching

35. Activities/exercises are provided in:	*Tick one box only*	
Written text in English.		1

No written text, written Maths terminology / numbers / Maths notation only	2
Orally in English / African language but mainly English	3
Orally in English / African language but mainly in African language.	4
Activities not used	5

36. Learners answer or write activities in: *Tick one box only*

English	1
Maths terminology / numbers / Maths notation only	2
English / African language but mainly English	3
English / African language but mainly African language.	4
Activities not used	5

37. Teacher instructs in: *Tick one box only*

English	1
African language with Maths terminology / numbers / Maths notation in English.	2
English / African language but mainly English	3
English / African language but mainly African language	4

38. In teacher-learner interactions, learners mainly use: *Tick one box only*

English	1
African language with Maths terminology / numbers / Maths notation in English	2
English / African language but mainly English	3
English / African language but mainly the African language	4
No teacher-learner interaction	5

39. In learner-learner interactions, learners mainly use: *Tick one box only*

English	1
Afrikaans	2
African language with Maths terminology / numbers / Maths notation in English	3
English / African language but mainly English	4
English / African language but mainly African language	5
Learners do not interact	6

Any other comments?..

....

....

Assessment

40. How are learners assessed? *Tick one box only*

learners' oral responses		1
learners' written work/other product		2
both		3
learners not assessed		4

41. How are learners provided with feedback?: *Tick one box only*

individually		1
as a class		2
both		3
feedback not provided		4

42. During the course of the lesson does the teacher do any of the following: *Tick one box in each row*

a)	check whether tasks are completed?	Yes	1	No	2
b)	correct exercises/tasks?	Yes	1	No	2
c)	spend time with individual learners discussing their work?	Yes	1	No	2
d)	have learners correct their own tasks in class?	Yes	1	No	2
e)	use learners' class/homework as a basis for class discussion?	Yes	1	No	2

43. If there is evidence of the teacher using class work to contribute towards learners' marks or is there other evidence of the teacher recording learners' learning **during the lesson**? If so, how is the teacher recording their learning? ....

....

....

....

....

Homework

44. Does the teacher give the learners homework? .... Yes 1 No 2

45. If yes, record the details in the space below ....

....

....

....

....

46. If yes, is there evidence **during the lesson** of the teacher doing any of the following: *Tick one box in each row*

a)	Checking whether the homework was completed	Yes	1	No	2
b)	Collecting, correcting or keeping homework	Yes	1	No	2
c)	Collecting, correcting and returning homework to learners	Yes	1	No	2
d)	Giving feedback on homework to the whole class	Yes	1	No	2
e)	Having learners correct their own homework in class	Yes	1	No	2
f)	Having learners exchange homework and correct it in class	Yes	1	No	2
g)	Using it as a basis for class discussion	Yes	1	No	2
h)	Using it to contribute towards learners' marks	Yes	1	No	2

Appendix 3.5: Teacher Interview 1

Teacher's full name: ....
School: .... Date: ....

TEACHER INTERVIEW

MATHEMATICS TOPICS

1. The two mathematics topics that we requested that you cover in your grade 7 maths lessons in the second term of 2000 are set out below, with the pages of the Learner's Activity Book, *'Maths for all'*, that we requested you to cover with your classes. Please indicate whether you were able to cover these topics in the second term and the approximate number of lessons which these sections took to cover. Four choices are provided for each topic: 1 - 5 lessons, 6 - 10 lessons; 11 – 15 lessons and more than (>) 15 lessons.

TOPIC	*Agree to teach in second term*				*Estimated number of lessons*							
	Yes	1	*No*	2	*1-5 lessons*	3	*6-10 lessons*	4	*11-15 lessons*	5	*> 15 lessons*	6
a) Measurement Pages 65 –78												
b) Decimals and percentage Pages 123 - 138												

2. Which of the following topics were you NOT able to cover this term?

TOPIC

a) Measurement

Topic	
Ideas of measurement and units	☐
Standard units……………………... (centimetres & millimetres)	☐
Length …………………………..	☐
Perimeter & area……………….. (of triangles, quadrilaterals, circles and other two dimensional shapes)	☐

b) Decimals and percentage

Topic	
Meaning, representation and use of decimal fractions	☐
Relationships between common and decimal fractions…………...	☐
Converting between fractions and decimal form………………..	☐
Concepts of percentages……….	☐
Computations and percentage…	☐

---

3. If you were not able to cover all of these topics, what were the reasons for this (probe for interruptions to their teaching, eg music competitions, personal bereavements, taxi/transport disruptions.) Roughly how many lessons were missed for each of these aspects?

---

4. Did you make use of the *Maths for all* textbook:

Every lesson   Twice a week Once a week   Occasionally   Never

---

5. Did you use other textbooks in addition to *Maths for all*, or other curricular material, in teaching mathematics to your grade 7 class in the second term of 2000?

tick one box

Yes	*No*

---

6. If yes, write in the title, author/publisher etc. of the textbook/s/material you used the most.

Title: ....

Author (or publisher): ....

Year: .... Other: ....

Title: ....

Author (or publisher): ....

Year: .... Other: ....

Title: ....

Author (or publisher): ....

Year: .... Other: ....

7. What maths book do you prefer to use/like to use the most? What is your reason for this?

---

8. For which purpose did you use *Maths for all* in most cases?

For guidance in planning and sequencing lessons	
Selecting examples to demonstrate new mathematical ideas to learners	
For selecting exercises for learners to do at home for homework	
Developing your own understanding of the mathematics content	
For selecting activities for learners to do in class	
For selecting exercises for learners to practice in class	

9. Did you cover the sections in *Maths for all* in the same sequence as the book, or did you select different parts from the book in your own order?

10. Are there any particular ideas or insights which you have gained from using *Maths for all* for teaching

a) measurement

b) decimals

c) other topics covered by the book

(Probe here for insights in relation to content, and insights in relation to pedagogy).

11. Would you recommend *Maths for all* to other teachers? If so, what strengths/positive aspects of the textbook would you emphasise the most? (Probe: what did you like most about the book?)

12. Please name, if possible, two activities (or sections) of *Maths for all* which you find particularly helpful (probe for reasons for why this is the case)?

13. Please name, if possible, two activities (or sections) of *Maths for all* which you found problematic and in need of improvement. (Probe: ask for why teachers did not like these activities)

14. What in your view are the main weaknesses overall of *Maths for all* as a textbook?

15. What recommendations would you make to the publishers for improvement of

- layout
- choice of exercises
- choice of activities
- way in which ideas are introduced and developed

16. Have you made use of the Teachers' Guide

Every lesson   Twice a week   Once a week   Occasionally   Never

17. Name, if possible, two insights you have gained from using the Teachers' Guide in teaching decimals and measurement? In teaching any other topic in the textbook?.

18. Do you have any recommendations to the publishers for improvement of the Teachers' Guide?

19. What direct access do learners have to *Maths for all* ? Do they

- have their own copies which they use only at school
- have their own copies which they use at school and can take home
- have copies for use in class time only, which are handed out and taken back each lesson
- have no access to the books, but get photocopied pages
- have no access to textbooks and no access to photocopies

---

20. In relation to Question 19 above, please explain your preference for granting students access to the textbooks. (Probe: ask teachers why learners are not allowed to take books home, if they are not)

---

21. How well do you expect your learners to perform in the maths test they wrote today?

THANK YOU for the thought, time and effort
you have put into assisting us with this interview.

Appendix 3.6: Teacher Interview 2

Interview Questions Mrs Tyandela

Teaching

1. Think of a lesson that you taught recently that is typical of your teaching. Now describe the steps that you follow in a lesson.
2. Now look at the video, is this an example of how you normally teach?
3. What would you change if you were to teach it again?
4. How did the lesson we video-recorded fit in with the lessons before and after?
5. Describe how you handled Activity 1 and 2 from the measurement chapter with your class?
6. Do you use group work in your teaching? When and for what?

Planning

1. Do you have a scheme of work for the year? For the term?
2. If not, how do you pace yourself?
3. What did you draw on (curriculum documents, textbooks) to plan
4. How did you use the *Mfa* LAB and TRB to plan this lesson?

Learners

1. Who are the bright/ fast learners in the class that we recorded?
2. Which learners struggle with mathematics in your class?
3. What in your opinion are the characteristics of a good maths learner?
4. What the parents of these learners do for a living? What kind of backgrounds do they come from?
5. Do the learners have any behavioral problems? Do learners disrupt lessons?

Mathematics

1 a) What are the learners' common misconceptions when dealing with length?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

2 a) What are the learners' common misconceptions about perimeter?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

3 a) What are the learners' common misconceptions about area?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

Textbook

I noticed that you handed out photocopies of pages from the textbook to your learners. Why do you give them photocopies when you have a set of textbooks?

Test

The learners at all the schools did not do very well on the tests. Why do you think your learners did not do well?

Interview Questions: Mrs Nkosi

On video

1. You tell them to rub the cover of their maths exercise book several times. Why do you repeat the instruction so many times.
2. I noticed that you handed out the textbooks from a box in the classroom to your learners. Did the learners return the books at the end of the lesson? Is this your usual practice with the textbooks? Why do the learners at the back have to share textbooks?
3. What are the learners confused about here? (in reference to counting the rows)
4. After reading question (a) from the textbook, what is happening in the class? (Teacher goes from group to group.)
5. At 38 min, can you translate that piece for me? (reference to two sides length and breadth)
6. It would help me if you outline the main steps in this lesson. What are your reasons for doing this step?

Teaching

1. Think of a lesson that you taught recently that is typical of your teaching. Now describe the steps that you follow in a lesson.
2. Now look at the video, is this an example of how you normally teach?
3. What would you change if you were to teach it again?
4. How did the lesson we video-recorded fit in with the lessons before and after?
5. How did you teach perimeter?
6. How did you teach length?
7. Do you use group work in your teaching? When and for what?

Planning

1. Do you have a scheme of work for the year? For the term?
2. If not, how do you pace yourself?
3. What did you draw on (curriculum documents, textbooks) to plan
4. How did you use the *Mfa7* LAB and TRB to plan this lesson?

Learners

1. Who are the bright/ fast learners in the class that we recorded?
2. Which learners struggle with mathematics in your class?

3. What in your opinion are the characteristics of a good maths learner?
4. What the parents of these learners do for a living? What kind of backgrounds do they come from?
5. Do the learners have any behavioral problems? Do learners disrupt lessons?

Mathematics

1 a) What are the learners' common misconceptions when dealing with length?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

2 a) What are the learners' common misconceptions about perimeter?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

3 a) What are the learners' common misconceptions about area?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

Test

The learners at all the schools did not do very well on the tests. Why do you think your learners did not do well?

Interview Questions: Mr Faku

Teaching

1. Think of a lesson that you taught recently that is typical of your teaching. Now describe the steps that you follow in a lesson.
2. Now look at the video, is this an example of how you normally teach?
3. What would you change if you were to teach it again?
4. How did the lesson we video-recorded fit in with the lessons before and after?
5. Throughout this lesson you call learners to the board, why do you do this? What purpose does it serve?
6. Do you use group work in your teaching? When and for what?

Planning

1. Do you have a scheme of work for the year? For the term?
2. If not, how do you pace yourself?
3. What did you draw on (curriculum documents, textbooks) to plan
4. How did you use the *Mfa* LAB and TRB to plan this lesson?

Learners

1. Who are the bright/ fast learners in the class that we recorded?
2. Which learners struggle with mathematics in your class?
3. What in your opinion are the characteristics of a good maths learner?
4. What the parents of these learners do for a living? What kind of backgrounds do they come from?
5. Do the learners have any behavioral problems? Do learners disrupt lessons?

Mathematics

1 a) What are the learners' common misconceptions when dealing with length?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

2 a) What are the learners' common misconceptions about perimeter?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

3 a) What are the learners' common misconceptions about area?

b) What are the best ways of dealing with these misconceptions?

c) How does *Mfa* help with these misconceptions?

Textbook

I noticed that you handed out photocopies of pages from the textbook to your learners. Why do you give them photocopies when you have a set of textbooks?

Test

The learners at all the schools did not do very well on the tests. Why do you think your learners did not do well?

Interview Questions: Mr Mafilika

Teaching

1. Think of a lesson that you taught recently that is typical of your teaching. Now describe the steps that you follow in a lesson.
2. Now look at the video, is this an example of how you normally teach?
3. What would you change if you were to teach it again?
4. How did the lesson we video-recorded fit in with the lessons before and after?
5. Throughout this lesson you call learners to the board, why do you do this? What purpose does it serve?
6. You used group work in your lesson? When and for what?

The lesson

1. At the beginning of the lesson you didn't inform the learners that you were dealing with area and perimeter, can you explain your strategy in this lesson?
2. In this lesson you read the questions to the learners, can you explain why you do read the questions and not the learners?

Planning

1. Do you have a scheme of work for the year? For the term?
2. If not, how do you pace yourself?
3. What did you draw on (curriculum documents, textbooks) to plan
4. How did you use the *Mfa* LAB and TRB to plan this lesson?

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b) What are the best ways of dealing with these misconceptions?

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Textbook

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Test

The learners at all the schools did not do very well on the tests. Why do you think your learners did not do well?

Chapter 4
Measurement

In this chapter we ask questions about size. We look at the size of lines, of flat figures and of solids and explore different ways of measuring them. We will get to know what numbers we need before we can measure the objects.

Outcomes for this chapter SOs 1, 5, 7, 9 & 10

After working through this chapter, you should be able to:

- Measure using non-standard units
- Use and understand standard units of measurement
- Convert between different standard units for length
- Use formulas to calculate area, perimeter and volume
- Solve problems involving length
- Solve problems involving area and perimeter
- Solve problems involving volume and surface area

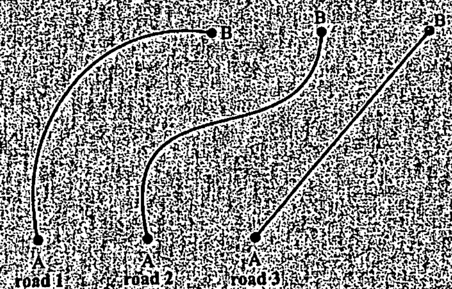
4.1 How long is it?

In this section we are interested in how big a line is. To answer this question, the activities investigate ways of measuring length.

Activity 1 The longest line

Use any apparatus such as a pencil, ruler, tracing paper, scissors, string or a pair of compasses to answer the questions below.

Two towns can be represented by two points, A and B. Two curved roads and one straight road join them, as shown.



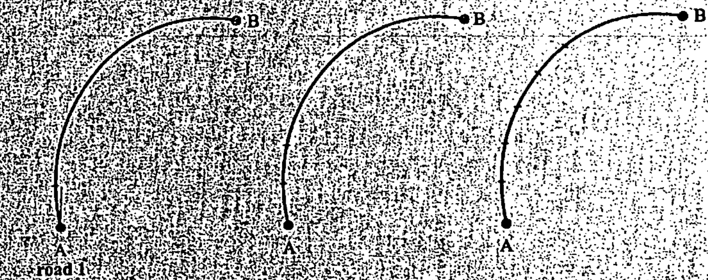
1. Which one of the three roads is the longest? Which road is the shortest?
2. How did you work out which road is longest or shortest? Which apparatus did you use?
3. Can you say how much longer or how much shorter the roads are compared to each other? Explain your answer.
4. In class, compare the different methods used to measure the length of the roads and discuss them.

187

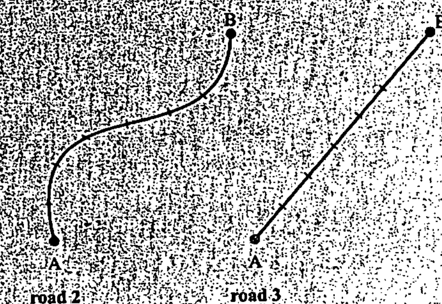
- We hope you came up with many different ways of measuring these roads.
- You can compare your methods to the one we suggest in the next activity.

Activity 2 Measuring length

1. Draw a short, straight *line segment* on a page: ——
2. Copy road 1 from Activity 1 onto lunch wrap or tracing paper.
3. Place the traced road 1 onto your line segment so that the endpoints of the two lines meet.
4. Mark points on the traced road as shown below:



5. Now trace road 2 and road 3 from Activity 1, and use your line segment to mark points along them as well.

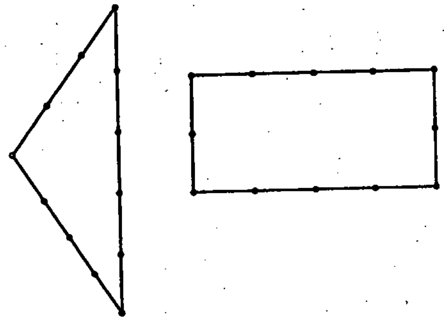


a) Can you work out now which of the three roads is longest and which one is shortest?
b) Explain how you worked out your answer this time.
c) How much longer is the longest road than the shortest road?
d) Compare your answers in class and discuss any differences.
e) Would a longer or a shorter line segment be better to measure with? Discuss this with a friend.

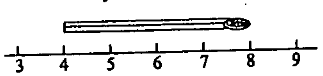
- In this activity you measure the lengths of the roads by using a small straight line segment as a unit of measurement. We call this line segment a *unit of length*.
- The length of each road is found by adding up the units of length that fit on it.
- The longer the road, the more units of length fit on it.
- By using a unit of length, you are able to say how much longer or how much shorter the roads are compared to each other.
- The smaller (or shorter) the units of length, the greater the number of them that will make up the full length of a road. The smaller (or shorter) the units of length, the more accurately you can measure.

Exercise 1 Practice with units of length

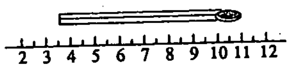
1. a) Two pieces of string are used to make the shapes alongside. The lengths of string have equally spaced knots in them. Which shape uses the longer piece of string, or are they formed with equal string lengths?



   b) Draw the unit of length used here.
   c) Cut a piece of string or wool to the same length as that used to make the shapes here. Use the wool to form other straight-edged shapes. Draw pictures of each one.
2. Use matchsticks as your unit of length to measure the length, width and thickness of your mathematics textbook. Compare and discuss your answers in class.
3. Measure the height of your desk in pencil lengths. Compare and discuss your answers in class.
4. Two students, Thelma and Zulaigha, measure the length of a matchstick with rulers they have made themselves:



Thelma: the matchstick is 4 units long.



Zulaigha: the matchstick is $7\frac{1}{2}$ units long.

Thelma's ruler measures the matchstick as 4 units long, while Zulaigha's ruler measures it as $7\frac{1}{2}$ units long.

a) How did Thelma measure the length of the matchstick, if she started from 4, and not 0, on her ruler?
b) Why do Thelma and Zulaigha have different measurements for the same matchstick?
c) Thelma measures the length of her exercise book using her ruler shown above. She measures it as 26 units long. How many matchsticks long is this? What will it measure on Zulaigha's ruler?

Activity 3 Units for all

1. Make your own paper ruler, using your own secret unit of length. Give your unit a special name.
2. Now use your paper ruler to measure the length of this line:
3. Compare your answers in class. Using the answers only, work out who has the shortest and who has the longest unit of length. Does anybody have the same unit of length as you?
4. If your whole class would like to have the same measurement for the same line, how could you solve the problem? Discuss this with a friend.

- In this activity you see that all the measurements in class will be the same only if the same unit of length is used by everybody.
- Units of length that have been set for everybody to use are called *standard units*.
- In the world today, we mostly use units of length that have been standardised for everybody to use. For example, on most rulers two standard units of length are marked out: *centimetres* (cm) and *millimetres* (mm).
- *Metre* sticks are 1 metre long and also have centimetres and millimetres marked out on them.
- It is useful to note that:

1 cm unit ——
10 mm units ||||||||||
10 mm = 1 cm
100 cm = 1 m

Exercise 2 Using millimetres and centimetres

1. Find the length of a matchstick in millimetre units and in centimetre units.
2. Which standard unit of measurement would be most suitable for measuring:
   a) the thickness of a coin?
   b) the length of a belt?
   c) the length of a fence around your school?
   d) the distance between two towns?
3. *Convert* the following lengths in centimetre units to millimetre units:
   a) 2 cm
   b) 2,5 cm
   c) 11 cm
   d) $5\frac{1}{4}$ cm
4. Convert the following millimetre units to centimetre units:
   a) 20 mm
   b) 55 mm
   c) 32 mm
5. Long steel nails are often measured in a unit of length called the *inch*. One inch is about 25 mm long. What is the length of a 6-inch nail when measured in millimetres?

189

4.2 What covers it?

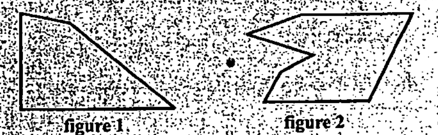
In the first section when we ask how big a line is, it is obvious that we are interested in its length. We also know that we can combine lines to form two-dimensional figures.

In this section, we ask how big a two-dimensional figure is.
What are we interested in this time?

Activity 4 Which figure is bigger?

Make a copy of the figures given below, then find a method of answering the questions as accurately as you can.
Use whatever apparatus you need: pencil, tracing paper, scissors, string, ruler, etc.

1. Which of the two figures below is bigger? Explain how you worked out which figure is bigger.

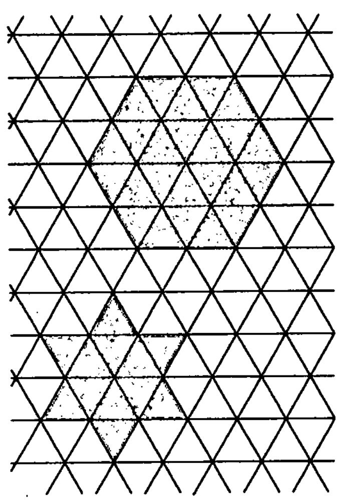


2. Compare and discuss the different methods used in class.

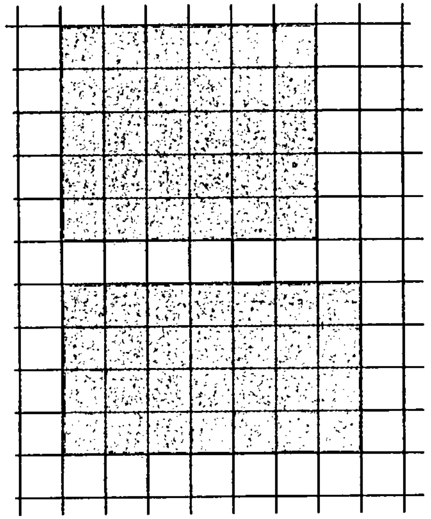
We hope that you came up with good ways of measuring the figures in Activity 1! You can compare your methods to the method we suggest in the next activity.

Activity 5 How big are these figures?

We have drawn the figures below on triangular and square *grids*. See if the grids help you to answer the questions.



triangular grid

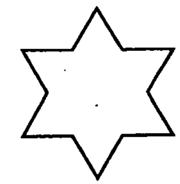


square grid

1. Which figure on the triangular grid is bigger?
2. Which figure on the square grid is bigger?
3. In each case, how did you work out your answer?
4. Compare your methods to those used by others in your class?
5. a) Design your own grid. Try not to use triangles or squares. Compare grids in class.
   b) Draw a three-sided and a five-sided figure on your grid. Ask a friend to work out which figure is bigger.

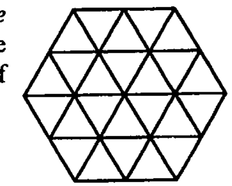
In this activity you see that when we ask how big a figure is, we can be interested in two measurements:

- Firstly, we count all around the edges of the figure. Counting in this way gives us the *perimeter* measurement of the figure. This is the total length around the figure.



measuring perimeter:
12 units of length

- Secondly, we can count how many *triangular* or *square units* cover the figure. Counting in this way gives us the *area* measurement of the figure. This is the amount of space inside the figure.

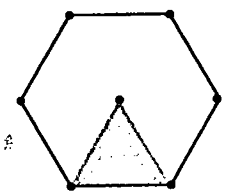


measuring area:
24 triangular units

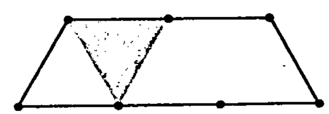
- We see, then, that whereas the perimeters of this *hexagon* and star are the same, the hexagon has a greater area than the star.
- In Question 5, did you notice that all the grids that were useful for measuring used shapes that cover the page without gaps?

Exercise 3 Practising area and perimeter

1. How many triangular units will cover each figure below?

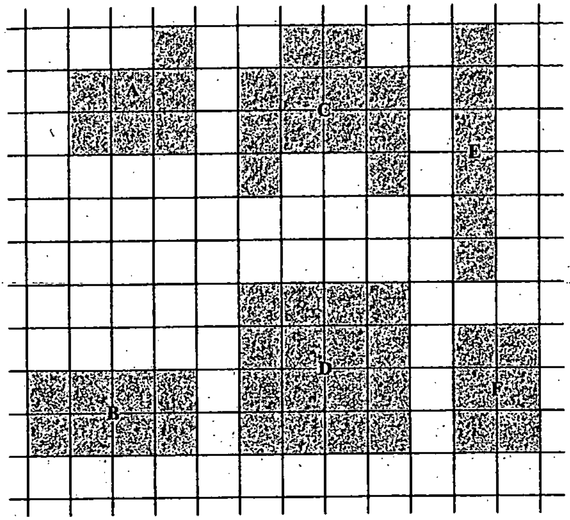


(a)



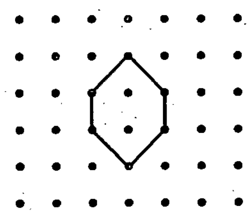
(b)

2. a) Find the area and perimeter for each pair of figures alongside.
   b) Say which figure in each pair is bigger. Explain why.
   c) Describe how you found the area of the figures.
   d) Describe how you found the perimeter of the figures.
   e) What is the difference between area and perimeter?

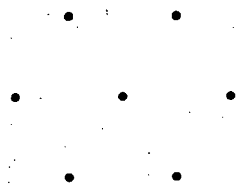


pair 1 pair 2 pair 3

3. Calculate the area of the hexagon below in square units:

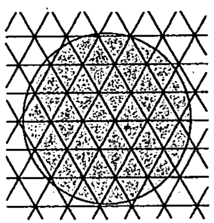


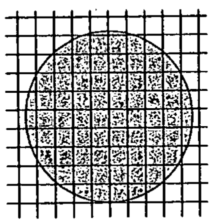
4. Copy the dots below three times.

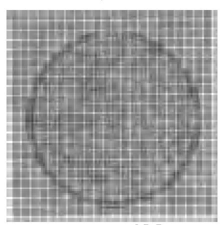


Use the dots to make a figure with an area of:
a) 3 triangular units
b) 4 triangular units
c) 6 triangular units.

5. The same circle is placed on each of three grids, as shown below:


triangular grid


square grid 1

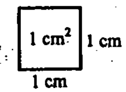

square grid 2

191

a) Work out the area of the circle, as best as you can, using each of the grid units given.
b) The circle on each grid is the same. Why do your answers differ?
c) Which grid do you think is the best to work from, if you want the circle area to be as accurate as possible? Why?
d) How would you improve on the grid you chose?

In the next activities we focus only on rectangles. We look at shorter ways of calculating the area and the perimeter of rectangles without having to count square or triangular units all the time. We shall use standard units of length for measuring perimeter.

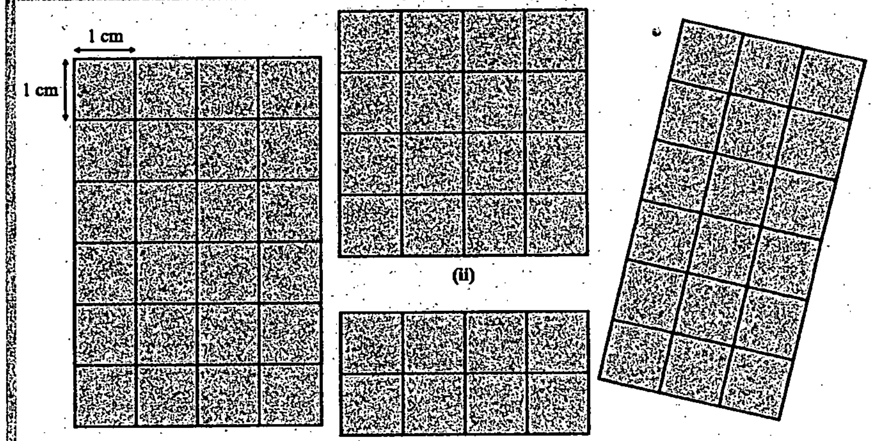
We introduce a standard unit for measuring area: the *square centimetre unit*.



the square centimetre unit

Activity 6 Quick-counting

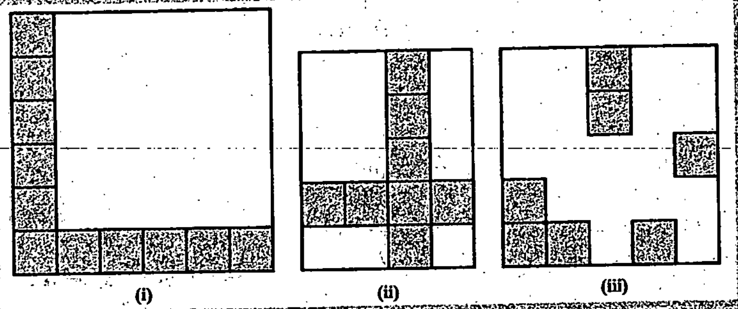
1. The rectangles given below are covered or tiled with square centimetre units.



(i) (ii) (iii) (iv)

a) Calculate the areas of each rectangle in square centimetre units.
b) Calculate their perimeters in centimetre units.
c) Did you count all the square centimetre units in each rectangle, or did you use a shortcut to calculate the area? Explain your shortcut to a friend. If you did not use a shortcut, can you think of one?

2. The rectangles below are partly tiled. Try to answer the questions below without filling in all the tiles.



a) Calculate the area of each rectangle.

b) Calculate the perimeter of each rectangle.

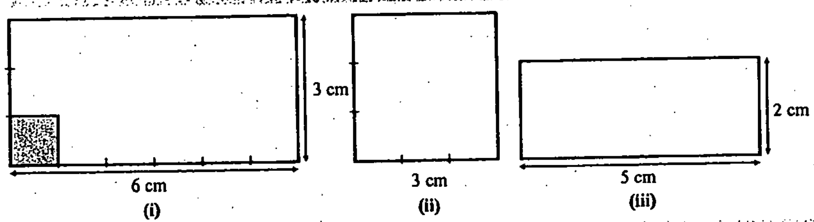
192

Were you able to calculate the area and perimeter without counting or filling in all the square units?

In the next activity you will see that there is a short way to calculate the area and perimeter of rectangles.

Activity 7 Making the rules

1. a) Calculate the area, in square centimetre units, of the rectangles below.
   b) Calculate the perimeter, in centimetre units, of each of the rectangles.

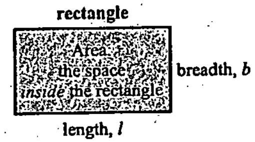


2. Now copy and complete the table below.

rectangle	*(i)*	*(ii)*	*(iii)*
length	6 cm	3 cm	?
breadth	3 cm	?	?
area	?	?	?
perimeter	?	?	?

3. What is the relationship between the length, breadth and area of the rectangles?
4. What is the relationship between the length, breadth and perimeter of the rectangles?
5. A fourth rectangle has a length of 12 cm and a breadth of 4 cm. Calculate the area and perimeter of this rectangle.

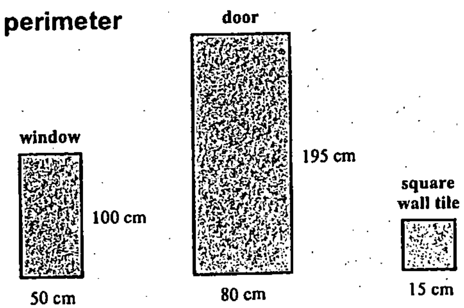
- In this activity you see that the area of a rectangle can be found by multiplying its *length* and *breadth*.
- We say: Area = length × breadth
- A short way to write this rule is to use letters only: $A = l \times b$
- One way of finding the perimeter of a rectangle is by adding the two equal lengths and two equal breadths together.
- We say: Perimeter = 2 lengths + 2 breadths or $P = (2 \times \ell) + (2 \times b)$



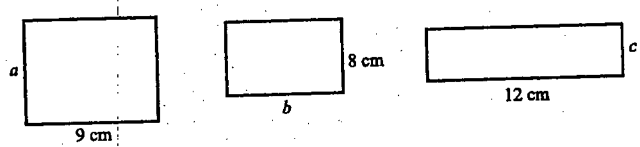
Exercise 4 Calculating area and perimeter

Use the rules for finding area and perimeter in the questions which follow:

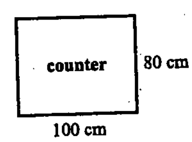
1. Find the area and the perimeter of the objects drawn here:

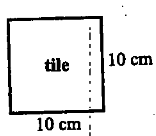


2. The following figures all have a perimeter of 36 cm.
   Find the lengths of the missing sides, shown by the letters a, b and c.



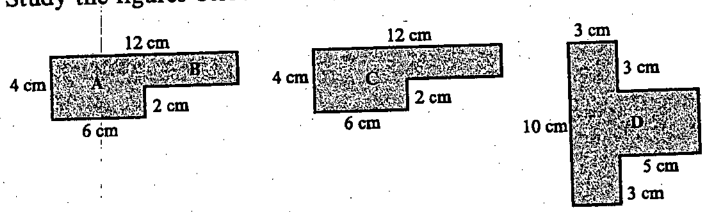
3. Draw at least five rectangles with an area of 48 cm^2.
4. Find objects in your room that have the following approximate areas:
   a) 1 cm^2
   b) 6 cm^2
   c) 400 cm^2
5. Sedica wants to tile the top of a counter next to the kitchen sink. The top of the counter is 100 cm wide and 80 cm long.





The tiles she wants to use are 10 cm long and 10 cm wide.
How many tiles are needed to cover this area?

6. Study the figures below.



   a) What is the area of A?
   b) What is the area of B?
   c) Now what is the area of C?
   d) Find the area of D.

Chapter 4
Measurement

Introduction

This chapter problematises the issue of size of various objects. The idea is to consider size in terms of different measurements. The question "Which one is bigger?" is intentionally ambiguous so that learners are forced to consider both area and perimeter measurements of polygons, and volume and surface area measurements of polyhedrons. It is important that learners agree that any of these measurements could be used to answer the question "Which one is bigger?"

The sections are sequenced in such a way that there is a progression from measuring 1-dimensional space in terms of length, to 2-dimensional space in terms of perimeter and area and finally, 3-dimensional space in terms of volume and surface area. It is important for you, at the end of the chapter, to reflect on this progression with learners. You should also look at the different units of measurement and compare the use of linear, square and cubic units.

You will notice that in each section learners are encouraged to come up with their own measurement strategies, to write their own rules, and to consider what would be appropriate units of measurement. Give learners plenty of time to do this, rather than rushing them into the use of formulas. Since this chapter is very long, and lots of new concepts are developed, we suggest that you do not rush to complete the chapter in one go, but rather take a section at a time, and work on other number chapters in between, before coming back to the next section in this chapter.

Specific Outcomes and Assessment Criteria

MLMMS Specific Outcomes and Assessment Criteria:

SO 1	Demonstrate an understanding about ways of working with numbers. (AC 1, 3, 4, 7)
SO 5	Measure with competence and confidence in a variety of contexts. (AC 1, 2, 5)
SO 7	Describe and represent experience with shape, space, time and motion using all available senses. (AC 1-4)
SO 9	Use mathematical language to communicate mathematical ideas, concepts, generalisations and thought processes. (AC 1-6)
SO 10	Use various logical processes to formulate, test and justify conjectures. (AC 1, 2, 3)

Related Specific Outcomes and Assessment Criteria from other Learning Areas:

LLC SO 1	Make and negotiate meaning and understanding. (AC 1-9)
LLC SO 2	Show critical awareness of language use. (AC 6)

LLC SO 6:	Use language for learning. (AC 1-4)
LLC SO 7:	Use appropriate communication strategies for specific purposes and situations. (AC 1, 3)
NS SO 3:	Apply scientific knowledge and skills to problems in innovative ways. (AC 1-8)
NS SO 5:	Use scientific knowledge and skills to support responsible decision making. (AC 1-6)
T SO 1:	Understand and apply the technological process to solve problems and satisfy needs and wants. (AC 1-3)
T SO 2:	Apply a range of technological knowledge and skills ethically and responsibly. (AC 1, 5)
T SO 4:	Select and evaluate products and systems. (AC 1)
T SO 5:	Demonstrate an understanding of how different societies create and adapt technological solutions to particular problems. (AC 1-4)
T SO 6:	Demonstrate an understanding of the impact of technology. (AC 1)
LO SO 5:	Practise acquired life and decision making skills. (AC 1)

After working through this chapter, learners should be able to:

- Measure using non-standard units.
- Use and understand standard units of measurement.
- Convert between different standard units for length.
- Use formulas to calculate area, perimeter and volume.
- Solve problems involving length.
- Solve problems involving area and perimeter.
- Solve problems involving volume and surface area.

Prior knowledge and skills

In this chapter, we assume that learners have had some experience of the following:

- Basic length measurement using a millimetre or centimetre ruler.

Links within the book

Project 2: Touring Planet Zoastria

Part of this project requires learners to measure and compare distances between places on their nets and their models. They could use any appropriate units of measurement to do this.

The Teacher Resource Book also suggests an extension activity for this project which requires learners to draw up a distance chart by measuring distances between places on the map in centimetres or millimetres and then converting them to an imaginary unit, 'verts', to find the 'actual' distance on the planet.

Project 4: Designing your own house

Learners need to take the measurements of the dimensions of the rooms in the house. This project requires an understanding of units of measurement and conversion between units, as well as the use of suitable measuring instruments.

Project 5: Funky school gear

This project is all about measuring lengths and thus provides an ideal opportunity to apply much of what has been learnt in this chapter. Learners may need to convert between measuring units and become familiar with using a measuring tape. The project also develops learners' visualisation and problem-solving skills.

Project 6: Growing mould

This provides learners with a dynamic area investigation situation. The mould grows at a certain rate and into a very irregular shape. Learners have to work out how, and in which units, to measure the area of the irregular, flat shape which the mould makes.

Project 9: Buckets of fun

Although this project is mostly about data collection, learners have to measure volume using buckets, measuring jugs and cups. As an extension to this project, you could discuss conversion between units for volume by comparing how many millilitres of water fill a cup, and how many cups of water fill a jug, etc. You could also use this opportunity to discuss the differences and similarities between talking about and measuring the volume of a bucket and the volume of a rectangular prism.

Investigation 2: Marking out a garden

In this investigation learners have to apply their knowledge of area and perimeter of a rectangle.

Chapter 7: Decimals and percentage

Measurement contexts are used to introduce and discuss decimal notation, and learners also have more opportunities to practise unit conversion.

Chapter 9: All about angles

This chapter introduces a measuring unit for non-linear measurements. It explicitly compares linear and angular measurement and it is important that learners come to see the differences between them. At the end of *Chapter 4* you could say to learners that this discussion is coming up later.

4.1 How long is it?

In this section learners explore strategies for comparing and measuring length. Situations are presented that are not readily answered by using a ruler. The learners' search for, discussion and comparison of these strategies leads them to a clearer understanding of length and measurement. The move from the learners' own units to the standardised units (millimetres, centimetres, and metres) develops a flexible and working understanding of units and conversion between them.

You can stimulate discussion by asking questions such as: What determines which units are most suitable? Can learners agree on a 'best' unit? How suitable are the standardised metric units? What do learners know of the inch? What about instruments like rulers and measuring tapes? What are they designed for?

Encourage learners to work in pairs for the first two activities in this section.

Activity 1 The longest line

Give learners time to come up with the best possible strategies for finding the longest and shortest paths. Encourage creativity in thinking about strategies and discussion amongst learners. Have the class decide which pair produced the best strategy: they need to consider both the accuracy and the simplicity of the strategy.

It is likely that many learners will use string to compare length. A connection may be made here with map work, where non-straight distances between positions, like cities, are determined in this way. The fashion designer's measuring tape is a similar, flexible tool for determining curved lengths, like waist or neck sizes. You can discuss the usefulness of such a measuring instrument when learners do *Project 5*.

Activity 2 Measuring length

For copying from the book, overhead transparencies or tracing paper are ideal. However, lunch wrap is a suitable substitute – draw on the non-greasy side.

Question 5 may present an initial stumbling block to some learners. They need to think carefully about it, and then answer according to their own understanding as developed in the activity. The line segment shown for marking off equal segments on the curves is only a suggested unit for measuring. The greater the variety of lengths chosen, the better the comparison and discussion will be later. The strategy of approximating curve length, also called arc length, using straight line segments is used in calculus to derive formulas for the exact arc length, using the notion of limit or infinitely small line segments. Learners should compare their work, to check that they are following the instructions correctly: remind them to make use of both the illustrations and the text.

The following are some questions which you can use to stimulate discussion after this activity:

- What is meant by the length of something?
- Why are all the learners' answers to Question 5(c) not the same?
- What is the length of each of the curves? Would you expect answers in class to be the same now? Why or why not?
- Which units of length, the longer or shorter line segments, will give more accurate length measurements?
- What is the point of having bigger or smaller units of length?
- Can learners see the link between this activity and the calibration of a ruler? Or the link between centimetres and millimetres?

Exercise 1 Practice with units of length

This exercise involves practical activities that reinforce the concepts developed in the activities. A variety of objects, like matchsticks, pencils and knots in a string, provide for a variety of units for length measurement.

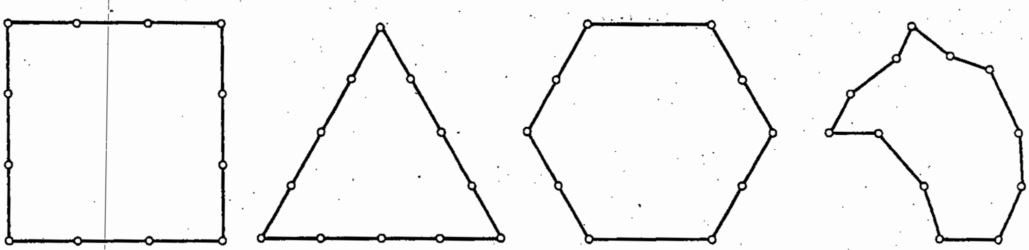
Questions 2 and 3 provide a good introduction to discussion about the use of appropriate units of measurements in particular situations. Spend time discussing solutions to Question 4 as a whole class.

Solutions

1. a) Both perimeters are 12 units long.

b) The length of the distance between 2 knots.

c) Some possibilities are shown on the next page:



Any closed shape made of the same 12-segment or 13-knot string or wool: there are many other possibilites.

2. Encourage learners to express answers in fractions of a matchstick, e.g. $\frac{1}{2}$ matchstick or $\frac{3}{4}$ matchstick.

3. Treat in the same way as Question 2: learners can express answers in fractional pencil units if necessary.

4. a) Thelma counted the number of units from 4 to 8. She obtained 4 units.

   b) Zulaigha measured in smaller units, so $7\frac{1}{2}$ of her units will be equivalent to the 4 units on Thelma's ruler.

   c) 4 Thelma units = 1 matchstick unit

   26 Thelma units = $\frac{26}{4}$ matchstick units = $6\frac{1}{2}$ matchstick units

   $7\frac{1}{2}$ Zulaigha units = 1 matchstick unit

   Book = $6\frac{1}{2}$ matchstick units

   Book = $6\frac{1}{2} \times 7\frac{1}{2}$ Zulaigha units = $48\frac{3}{4}$ Zulaigha units.

Learners may have a variety of ways of calculating these answers!

Activity 3 Units for all

The ruler that learners make should be positively influenced by the work done in Activity 2. Designing a ruler is one way to improve learners' understanding and use of measuring instruments and calibration.

Question 3 in the activity focuses attention on the link between smaller and bigger units – an essential connection if learners are to convert units sensibly. Question 4 should lead to the idea of standardisation of units within the class. Some questions for consideration may be: What would make good standardised units? Could they satisfy everyone? How would standardised units be useful?

Draw learners' attention to the notes on standard units after the activity, and in particular the conversion between standard units.

Extension idea

The processes of decision-making, compromise, and agreement on suitable units offer insights into how society, and the international community, establish standardised units and systems of units. The process could be consultative and democratic, or entirely dictatorial. On the one hand, therefore, there is an opportunity to engage learners in democratic processes or practices, while on the other it opens up the contested nature of some areas of mathematics. Standardised units are not absolute or perfect units. They are decided on, or agreed to, but may be discarded when better ones become necessary. Through such debate and engagement, the concepts of mathematics as a human activity, mathematics and society, mathematics as a transformational agent (toward democratic values, practices and society) are concretised.

Exercise 2 Using millimetres and centimetres

This exercise provides practice in basic conversion between millimetres and centimetres, using 10 as the conversion factor.

Solutions

1. About 40 mm or 4 cm
2. a) millimetres b) centimetres c) metres d) kilometres
3. a) 20 mm b) 25 mm c) 110 mm d) 52,5 mm
4. a) 2 cm b) 5,5 cm c) 3,2 cm
5. 6 inches × 25 mm per inch = 150 mm

4.2 What covers it?

In this section, the following question is put to learners: How big is a 2-dimensional flat figure? More mathematically, the question is about measuring area. The chapter is written in such a way that learners can see the extension of measurement strategies as they progress from measuring length and perimeter, to measuring area and volume. A sense of the connections within mathematics is thus developed.

Encourage learners to be creative and adventurous in their exploration and strategies. They should not feel restricted to using only the suggested apparatus.

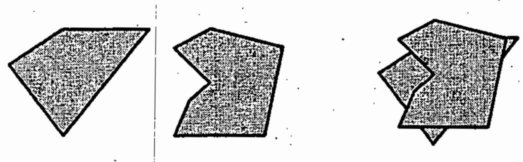
Activity 4 Which figure is bigger?

Encouraging learners to work in pairs should facilitate exciting debate around useful or clever measuring strategies which can be used in the activity.

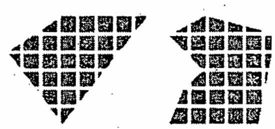
As a teacher you may want to provide learners with more interesting initial shapes, like the land space of Robben Island, cut-outs of the shape of the African continent, the shape of a car or diamond. You could also use *Project 6: Growing mould.*

Learners must produce strategies which will allow for reasonably accurate comparison of the size of flat figures. Some possibilities are listed below:

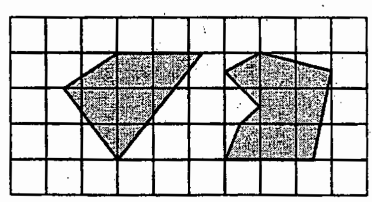
- They could cut out the figures and then compare them by fitting the one on top of the other.



- The figures could be cut into a number of smaller, equal-sized, regular shapes, like squares. The smaller units are then counted and compared for each polygon.



- They may use grid paper, or set up their own grids for measuring purposes.
- Learners may, of course, also think of size in terms of perimeter and not area. Here string or ruler measurements along the perimeters would be a strategy.



The purpose of the activity is to stimulate debate around what is meant by the 'size' of polygons, or flat figures. Is it the total edge length (perimeter), or the enclosed space (area) of the figures? Learners should be able to see how the two measures are different. They also need to talk about when they should use perimeter, and when they should use area, for comparing the 'size' of flat figures. It is important to keep emphasising that both measures can be used to compare size as long as it is made clear which measure is being used.

Activity 5 How big are these figures?

This activity directs the learners toward a strategy for measuring the size of polygons, by using triangular and square grids.

Learners are still faced with the question: Is the size of a flat figure its area or its perimeter? The activity presents two different figures on the triangular grid, and two on the rectangular grid. In both cases, the figures have the same perimeter, but different areas: on the triangular grid, the perimeters are both 12 units, but the areas 24 and 12 units respectively; on the rectangular grid, the perimeters are both 22 units, but the areas are 30 and 28 square units respectively.

Since the perimeters are the same for each of the pairs of figures, and the question asks 'Which is bigger?', learners are forced to focus on the area of the shapes. An interesting question for learners would be: What is meant by bigger? Learners may need some time, but they do come up with answers like: 'Bigger means more square units or more triangular units'. Ask questions like: What is meant by bigger here? How do you know this one is bigger than that one? How did you work out that the one is bigger than the other? How much bigger is the one than the other? Such questions focus attention on the role of the units, and the counting of units as a measurement of area. The question is vital to the size concept and should form part of the class discussion.

Draw attention to the last note after this activity where reference is made to shapes that cover the page without gaps, i.e. shapes that tessellate. You can compare shapes that do not tessellate, and discuss why they are not suitable for measuring area.

Exercise 3 Practising area and perimeter

This is a basic exercise in counting square or triangular units and in developing the area and perimeter concepts a little further. Learners should realise that different figures can have the same areas or perimeters.

Learners could also investigate other possible figures, all having the same area, as an extension.

Solutions

1. a) 6 triangular units **b)** 5 triangular units

2. a)

Figures		*Area*	*Perimeter*
pair 1	**A** **B**	7 square units 8 square units	12 units 12 units
pair 2	**C** **D**	12 square units 16 square units	18 units 16 units
pair 3	**E** **F**	6 square units 6 square units	14 units 10 units

b) Learners must motivate how they decided which shape is bigger. They must show that they have considered both area and perimeter.

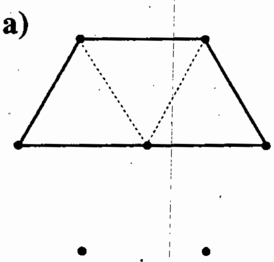
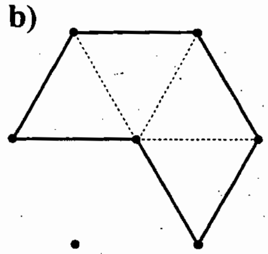
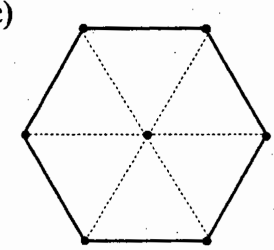
c) Area is found by counting the number of squares covered by the figure.

d) Perimeter is found by counting equal units around the edges of the figures.

e) Any reasonable explanation that shows an understanding of the difference between area and perimeter measurements.

3. Learners should realise that the triangular pieces at the top and bottom ends of the hexagon, are half a square unit. This shape has 4 such half-square units, which equal 2 whole square units. The total shape is then made up of 4 square units: 2 in the middle plus 4 triangular half-square units.

4. Again, only some solutions are presented here: you will have to check learners' responses carefully.

a)  b)  c) 

5. Learners must demonstrate that they can use a grid set-up to measure the area of a circle. This question differs from Activity 5 in that the edge of the circle is curved.

a) Triangular grid: The circle measures 33 to 35 triangular grid units;

Square grid 1: The circle measures 28 to 29 square grid units;

Square grid 2: The circle measures 125 to 130 smaller square units

b) Square grid 2 has smaller square units; hence more are needed to fill the circle than with the other grids.

c) Square grid 2 has smaller square units that cover more of the circle; less estimation is necessary and therefore it measures the circle area more precisely.

d) The grid could be divided into smaller square units, so that even less of the circle needs to be estimated as fractions of a square unit.

Activity 6 Quick-counting

In this and the next activity learners only measure rectangles. A shift is made from arbitrary square units to square centimetre units. The activities are designed to highlight counting strategies and shortcuts. All of this leads to the development of area and perimeter formulas. In Exercise 4: Question 6, learners are required to dissect non-rectangular shapes into rectangles so that they can use the area formula for rectangles to determine the areas of such shapes.

This activity encourages learners not always to count all the little square units, but to seek a quick method of counting all the squares when calculating area.

Ask learners what it is that they count when determining the area or the perimeter of these rectangles. Help them to see that the centimetre line segments are used for perimeter and the square centimetre units for area.

Activity 7 Making the rules

In this activity, the square units are removed so that learners may realise how the number of centimetre units along the edges of the rectangles determines the number of square centimetre units that will fill the enclosed area. A rectangle with a length of 6 cm and a breadth of 3 cm will have 6 square centimetre units along its length, and 3 square centimetre units along its breadth. If the entire rectangle is filled, the total number of square centimetre units will be 6×3 square centimetre units; hence the area of the rectangle is 18 cm^2.

The activity is geared towards getting learners to write rules for finding area and perimeter for themselves. When they have completed the activity, discuss the formulas given in the notes after the activity, and make sure that learners understand their meaning.

Exercise 4 Calculating area and perimeter

This exercise offers learners practice in calculating area and perimeter and in using the formulas.

Solutions

1. Window
   Area: $100 \times 50 = 5\ 000\ cm^2$; Perimeter: $2(50) + 2(100) = 300$ cm

   Door
   Area: $195 \times 80 = 15\ 600\ cm^2$; Perimeter: $2(195) + 2(80) = 550$ cm

   Square wall tile
   Area: $15 \times 15 = 225\ mm^2$; Perimeter: $4(15) = 60$ mm

   The perimeter formula can be written in a number of different ways:

   - $P = 2l + 2b$
   - $P = 2(l + b)$
   - $P = l + l + b + b$

   Encourage learners to present answers in a clear and logical way:

   Area of window: $A = l \times b$
   $= 100 \times 50$ (Units may be omitted)
   $= 5\ 000\ cm^2$ (Units must be specified in the answer)

2. Since the product of two adjacent sides gives the area, dividing one of the sides into the area gives the other side.

   $a = \frac{36}{9} = 4$ cm $\qquad b = \frac{36}{8} = 4{,}5$ cm $\qquad c = \frac{36}{12} = 3$ cm

3. If no fractions are used, there will be 5 rectangles:
   1×48; 2×24; 3×16; 4×12 and 6×8.
   Other possibilities would be $0{,}5 \times 96$; $1{,}5 \times 32$; $2{,}5 \times 19{,}2$, etc.

4. This question gives learners some visual reference for area and perimeter measurements. What, for example, does 6 cm^2 look like? How would these possibilities change if a perimeter of 10 centimetres is also specified? Would your learners recognise an area of about 400 cm^2 ? Would they be able to estimate the area of a table top or floor space? Learners should recognise that the area of any shape, including a circle, may be measured in terms of square units. (See Exercise 3: Question 5.)

   Some possible responses are given here, but learners should be encouraged to explore extensively:

a) A 1c coin; a rectangular object 2 cm long and $\frac{1}{2}$ cm wide.

b) A stamp, 3 cm long and 2 cm wide; a badge; an eraser.

c) A book cover or page, 25 cm long and 16 cm wide; a box lid 10 cm $\times$ 40 cm.

5. Area of one tile: $A = 10 \times 10 = 100 \text{ cm}^2$

Area of counter: $A = 100 \times 80 = 8\,000 \text{ cm}^2$

Number of tiles: $\frac{8000}{100} = 80$ tiles

6. a) Area of A: $6 \times 4 = 24 \text{ cm}^2$

b) Area of B: $6 \times 2 = 12 \text{ cm}^2$

c) Learners should use **a)** and **b)** to answer this:

Area of C $= \text{Area of A} + \text{Area of B}$

$= 24 + 12$

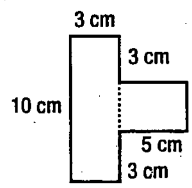
$= 36 \text{ cm}^2$

Many, however, will probably start their calculations from scratch!

d) Area of D $= (10 \times 3) + (4 \times 5)$

$= 30 + 20$

$= 50 \text{ cm}^2$



Learners may need some help in working out the width of the second rectangle.

4.3 What fills it?

In this section learners have to think about how to measure the size of 3-dimensional objects. The questions asked here follow a similar pattern to the previous two units, so learners should be quite familiar with the form of the investigation in the activities. The section develops an understanding of volume measurement.

Activity 8 Which polyhedron is bigger?

Learners have to consider what size means here. Their task is then to come up with different strategies to determine and then compare the sizes of polyhedrons.

Learners may use their experiences in the two earlier sections and use square units to compare faces, and then use this to compare the polyhedrons. They may also take a hint from the title of this section, and explore the use of cubes as a standard unit to fill the boxes, although this is not necessarily an expectation at this stage. They could also experiment with similar-sized boxes by covering the boxes with wrapping paper, and then comparing the size of the wrapping paper to see which box is bigger. You could suggest these strategies yourself if learners are stuck.

Activity 9 How big is a polyhedron?

In this activity two ways of measuring the size of a polyhedron are contrasted. What is the difference between volume and surface area? Question 1 forces learners to consider both measurements since in Pair 1, the polyhedrons have the same volumes but different surface areas. In Pair 2, the polyhedrons have the same surface area but different volumes. However it is not expected that learners

Appendix 4.3 Note 'To the learner' in Grade 7 *Maths for all* LAB

To the learner

Maths for all is a totally new textbook series written for Outcomes Based Education and Curriculum 2005. Outcomes Based Education and Curriculum 2005 is about active learning that encourages you to do things, to experiment, to build, to investigate, to try out and test new ideas and to share your ideas with others. It also means that you and your teacher should set clear goals and check whether you are meeting them.

Maths for all is based on your needs for a sound mathematical education that will allow you to leave school with relevant mathematical skills for living, working and further education or training.

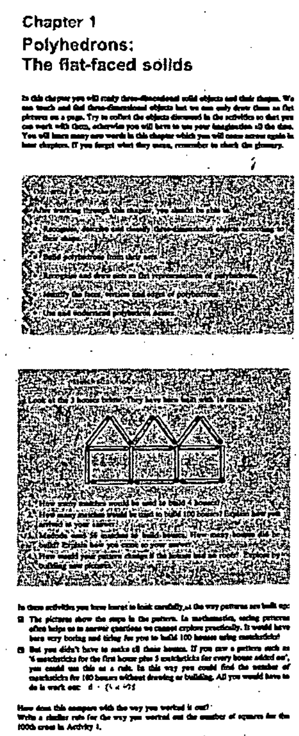
What is in *Maths for all* Grade 7?

We have tried to write a book that makes maths interesting, challenging and fun. The book consists of chapters, projects, investigations and a glossary. The chapters include activities, summary of activities and exercises. The projects and investigations are found between chapters.

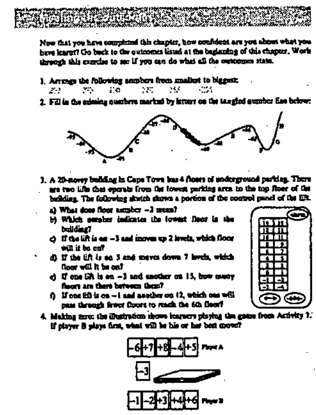
Chapters

Activities are marked out with grey panels in the chapters. You are meant to DO these activities in class, preferably, by working in pairs or groups. The activities are designed to encourage you to draw on familiar experiences and knowledge, to explore new ideas, to reflect on your own learning and to share your ideas through writing, drawing and talking. They should keep you busy and you should find them challenging and fun to do!

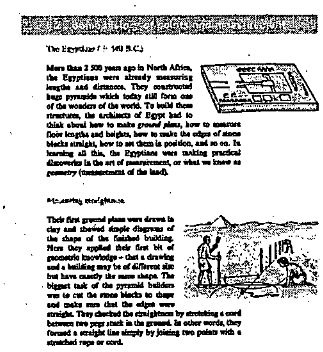
If you are uncertain about what you were meant to have learnt from doing an activity, refer to the bulleted points after the activity. These give a summary of the important mathematical concepts and skills that we want you to learn in the activity. Ask your teacher to discuss these points in class.


Chapter 1
Polyhedrons:
The flat-faced solids

You will notice that the exercises are not very long - we think you should work through all the questions! The exercises are designed to practice the ideas and skills developed through the activities. The last section in each chapter is called "Meeting the outcomes". If you can answer all the questions in this section then you have achieved all the chapter outcomes listed in the grey panel at the beginning of the chapter. You should therefore work through this section to check for yourself whether you have achieved all of the chapter outcomes. Where you have problems you should give yourself more practice by going back to work done earlier in the chapter. Ask your teacher for more examples.

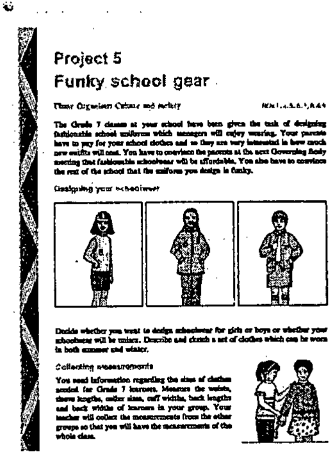


Some chapters have a history section. These sections are meant to show you that mathematics did not always just exist, but that it has developed over time through many social activities of ancient communities. We hope you come to see how mathematics has been, and can be used as a useful tool for solving practical social problems.



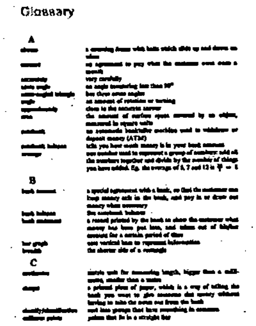
Projects and investigations

The projects and investigations are designed to present you with many challenging situations in which your mathematical and general knowledge can be used and applied. Here is where you should really have fun and use all of your creative talents to solve the problems. You should take care when presenting your projects and use the guidelines for assessment given at the end of each project.



Glossary

A glossary is like a mini dictionary that contains words and their meanings. We have included a glossary so you can easily find the meanings of words. Glossary words in the chapters and projects are written in italics, so that you can look them up at the back of the book. If you come across an unfamiliar word in the book at any time, we urge you to look it up in the glossary. If it is not there, then look it up in an ordinary dictionary. It is very important that you understand the meanings of words that you read. Furthermore, you will be surprised at how much you can learn from just reading the glossary!



Enjoy *Maths for all*!

Appendix 4.4 Note 'To the teacher' in Grade 7 *Maths for all* LAB

To the teacher

Maths for all is a totally new series of learners' activity books and teachers' resource books written for Outcomes Based Education and Curriculum 2005. *Maths for all* is based on the needs of learners for a sound mathematical education that will allow them to leave school with relevant mathematical skills for living, working and further education or training. In addition, the series encourages the development of learners' general language and comprehension skills.

Features of *Maths for all* Grade 7

Maths for all Grade 7 covers a range of mathematical topics, some familiar, but some which have only recently been included in learning programmes for this Grade. The book consists of chapters, projects, investigations and a glossary. Chapters have been sequenced to maintain the progressive development of concepts along the mathematical strands for geometry, arithmetic and algebra. However, you may choose to follow a different sequencing of chapters with respect to the strands. More suggestions for this are given in the accompanying Teacher's Resource Book.

Chapter Outcomes

Each chapter starts with a short description of its contents and intended outcomes. Encourage learners to focus on these outcomes and to measure their progress against them. Specific exercises have been included for this purpose and are described below under Meeting the Outcomes.

Specific Outcomes

The concepts and skills developed in the chapters build towards the Mathematical Literacy, Mathematics and Mathematical Sciences' (MLMMS) Specific Outcomes (SOs), Assessment Criteria and Range Statements identified for the Senior Phase. In addition, they build towards the development of several Specific Outcomes from other Learning Areas. A list of the outcomes developed in each chapter is given on the Contents page. In order for you to look up the references to these Specific Outcomes, we have included a table on the inside back cover, that contains all 66 Specific Outcomes from all 8 Learning Areas required for the General Education and Training Certificate. The grey panel on the opening page of each chapter shows only which MLMMS Specific Outcomes are developed in that chapter. Remember that the Specific Outcomes for the Senior Phase must be achieved over Grades 7, 8 and 9. Learners are not expected to have mastered all the outcomes at the end of Grade 7.

Activities

Activities are marked out with grey panels in the chapters. It is expected that concept and skills development takes place by working through these activities. The activities are designed to encourage learners to draw on familiar experiences and prior knowledge, to explore new ideas, to reflect on their own learning and to share their ideas through writing, drawing, making and talking. We would recommend that class time be taken up with working through the activities and that learners work co-operatively on these as far as possible.

Bulleted points at the end of each activity draw out the essential mathematical concepts and skills that are expected to be understood and achieved after working through the activity. These points should arise from whole class discussion of the activities but are included in the book for learners' later reference. The activities are also designed to facilitate links with other Learning Areas. Some of our ideas for these links are listed in the "Chapter by chapter commentary" in the accompanying Teacher's Resource Book, but you should feel encouraged to develop and make your own cross-curricular links where you can.

Exercises and Meeting the outcomes

The exercises are designed to consolidate the concepts and skills developed through the activities. As such, they can be used both for practice and assessment purposes. Each section within a chapter contains at least one exercise. The exercises are not very long so as to enable all learners to work through all the questions. Where possible these can be done at home. We do not expect learners to spend large amounts of class time on practice work. The last section in each chapter is called "Meeting the outcomes". This section consists of a graded exercise that can be used to assess to what extent the chapter outcomes listed at the beginning of the chapter, have been achieved. Every question can be used to assess at least two chapter outcomes (these are detailed in the accompanying Teacher's Resource Book) so that by the end of the exercise every outcome will have been assessed. In this way, learners and teachers can be aware of what concepts and skills need further development and practice.

History

Some chapters have a section on the historical development of particular mathematical concepts. These sections are meant to give learners a sense of mathematics as a human and social activity. In particular they build towards MLMMS Specific Outcome 3 which states that learners have to "demonstrate understanding of the historical development of mathematics in various social and cultural contexts". We hope learners come to see how mathematics has been, and can be used as a useful tool for solving practical social problems.

Projects

Projects are marked out with a bar on the sides of the pages. The projects are designed to present challenging non-mathematical contexts in which mathematical knowledge can be used and applied. They are positioned close to the chapters in which the required mathematical knowledge is developed. The projects are very explicit about what the cross-curricular links are. In particular, each project references one of the Phase Organisers identified for the Senior Phase. The full list of Phase Organisers are: *Personal Development; Culture and Society; Economics and Development; Environment and Communication.* A project can of course be linked to more than one Phase Organiser.

Projects are meant to be done over time and not necessarily during class time. The book contains ten projects. We do not expect your learners to work through them all, but rather to do as many as your time allows. Therefore, you should read through them all first before selecting which ones you will use. You may find that some projects are easier to set up in your situation than others. Projects may be done as consolidation or as a way into mathematical concepts. You can decide, therefore, whether to commence a project before or after doing a chapter, or even, while covering a particular chapter.

Again, we recommend that learners work co-operatively on these projects as far as possible. Guidelines for assessment are given at the end of each project.

Investigations

Investigations are marked with a bar in the same way as projects. There are six investigations and these require much less time to do than the projects. They have been included as challenging mathematical activities to be done for enrichment. The investigations are positioned close to related mathematical topics but are not necessarily direct applications of mathematical knowledge developed in the chapters. Very often, they serve as consolidation for some mathematical concepts learnt in prior chapters.

Glossary

Glossary words are found in italics in the chapters and projects. Encourage learners to use the glossary as frequently as they need to. If unfamiliar words are not there, encourage them to consult an ordinary dictionary. Familiarising learners with the use of such a common feature in books is an important part of developing their literacy skills.

***Maths for all* Teacher's Resource Book**

The Teacher's Resource Book contains detailed discussion of each chapter and their activities as well as the projects and investigations. These discussions include prior knowledge required for each chapter, links within the book, cross-curricular links, suggested classroom organisation and extension activities. In addition, selected solutions to activities and exercises are included.

Each chapter in the Teacher's Resource Book includes assessment grids related to the Learner Book chapters that may be used by you and learners for assessment purposes.

Appendix 4.5: Analysis of Activities 3-7 from *Mfa7* LAB

Activity 1 and 2 has already been discussed in depth in the main body of the thesis. The analysis of the remaining Activities of Mfa7.4 LAB is discussed below. In Activity 3 (*Mfa7.4* LAB: 69) learners have to design a paper ruler with a unique unit of length. The mathematical knowledge to be explored here is the need for standardised units which is achieved via the exploration of the effect of the unit of length on the measurement of a line. The bullet points (*Mfa7.4* LAB: 69) after Activity 3 explicitly explain the need for standardised units of measurement and provide conversions from centimetres to millimetres and from metres to centimetres. The text however does not provide a method for converting units of measurements. The bullet points simply state that '10 mm = 1 cm' and '100 cm = 1 m'. It appears that the method is left for learners to acquire themselves or for the teacher to explicitly teach a method for conversion. The absence of an explicit method or algorithm for the conversion of units suggests that the text backgrounds procedural knowledge. The purpose of the first three activities at this point becomes clear. It appears that learners should suspend their knowledge of rulers to explore the necessity for standardised units of length. This mathematical knowledge is only made explicit in the bullet points after Activity 3.

Activity 4 (*Mfa7.4* LAB: 71) and Activity 5 (*Mfa7.4* LAB: 72) work in much the same way as Activity 1 and 2. In Activity 4 learners are asked to compare the sizes of two-dimensional shapes using a variety of physical resources such as string, pencil, ruler, tracing paper, scissors, string or compass. The knowledge that learners are to discover is that the size of two-dimensional shapes can be determined by comparing the perimeter or area of the shapes. There are several possible ways of comparing the two shapes: using string to measure the perimeter of the shapes; fitting the shapes on top of each other to compare the area of the shapes, comparing the length of the shapes or comparing the width of the shapes. Multiple ways of comparing the size of two-dimensional shapes and how to measure two-dimensional shapes are therefore possible. The solution method of how to measure the shapes and what it means to find the size of shapes however is not made available to learners in the bullet points after Activity 4. Instead, the bullet points refer the learner to Activity 5 where grids are used to assist learners to measure two-dimensional shapes. In this way a particular solution method is privileged – the use of grids to measure two-dimensional shapes.

> This activity directs learners towards a strategy for measuring the size of polygons, by using triangular and square grids. (*Mfa7.4* TRB: 37)

A particular method of measuring two-dimensional shapes is suggested in Activity 5 but learners are left to investigate that finding the size of two-dimensional shapes involves measuring the area and perimeter of the shapes. The bullet points (*Mfa7.4* LAB: 73) after Activity 5 explicitly provide definitions of perimeter and area as two ways of measuring the size of two-dimensional shapes. The above discussion demonstrates again how the pedagogic strategies used to defer mathematical knowledge and in so doing achieve an inductive approach to teaching and learning mathematics. In the same way that Activity 1 is semantically dependent on Activity 2, so Activity 4 is semantically dependent on Activity 5, together forming a semantic unit. This semantic dependence is not made explicit in the *Mfa7.4* LAB or TRB.

Both activities are semantically dependent on the bullet points after Activity 5. These activities, particularly Activity 5 separated from the bullet points can potentially be read as a counting exercise where learners simply determine which shape is bigger on the triangular grid and on the square grid without recognising that they are dealing with area and perimeter.

Similarly, Activity 6 (*Mfa7.4* LAB: 71) and Activity 7 (*Mfa7.4* LAB: 71) appear to work together. The knowledge that learners are to discover is the formulas for calculating the perimeter and area of the rectangles. Learners are provided with rectangles tiled with square centimetre units. In the second question of Activity 6, some of the 'tiles' are removed from the rectangles. This is a strategy used to draw learners away from relying on counting only, to developing shorter more efficient methods for finding the area and perimeter of rectangles, to eventually to finding the formulas for area and perimeter of rectangles. The formulas however are not made available to the learner in the bullet points after Activity 6. Instead the learner is referred to Activity 7, where, in the three rectangles provided, square units are replaced with centimetre markings (rectangle 1). This is eventually replaced by the measurements of the length and breadth. Gradually the scaffolding is removed so that learners are obliged to relinquish counting as a means of finding the area and perimeter of the rectangles and in this way the text inductively leads learners to the formulas for perimeter and area of rectangles.

> In this activity, the square units are removed so that learners may realise how the number of square units along the edge of a rectangle determines the number of square units that fill the enclosed area. [...] This activity is geared towards getting learners to write rules for finding area and perimeter themselves. (*Mfa7.4* TRB: 39)

The bullet points (*Mfa7.4* LAB: 77) after Activity 7 provide the formulas for perimeter and area of a rectangle but no worked examples based on calculations of area and perimeter are provided. In this way, Activity 6 and 7 form a semantic unit where the mathematical knowledge is deferred and made explicit in the bullet points after Activity 7.

The analysis presented here, supports the findings outlined in the main body of thesis. The textbook uses a number of pedagogic strategies to support an inductive approach to the teaching and learning mathematics where the learner is encouraged to discover mathematics collaboratively with other learners and the teacher engages learners in discussion to elicit the mathematical knowledge.

Appendix 5.1: Mrs. Tyandela's lesson outline

Task	Time	Teacher	Learners
Review of previous work (16 min)	8,5 min	Hands out page from Mfa7 LAB and instructs learners where to paste it in their notebooks.	Watch and listen to teacher.
		Questions learners about Activity 1 and 2 in an attempt to review the activity and the conclusions they arrived at in previous lessons.	Answer questions sometimes individually and at times the class choruses answers.
		Demonstrates how to measure the chalkboard using short and long line segments.	Watch demonstration and answers questions.
	3,5 min	Draws triangle and rectangle from Exercise 1, question 1on the board.	Watch teacher.
		Recalls how learners answered question 1 in previous lessons.	Listen to teacher.
		Questions individual learners to recall the answers they had in previous lessons.	Answer questions.
	4 min	Recalls how the class answered question 2 of exercise 1.	Listen to teacher.
		Asks learners to recall answers to question 2 (measurements of length, breadth and thickness of mathematics textbook in matchstick lengths)	Answers questions.
		Demonstrates what the length, breadth and thickness of mathematics textbook is.	Watch demonstration.
		Asks learner to demonstrate the measurement of the breadth of textbook because he answered question incorrectly.	Learner demonstrates while the rest of the class watches.
Question 3 (22 min)	2 min	Instructs class to read Question 3 from the textbook.	The whole class reads question 3 aloud from the *Mfa7* LAB.
		Explains question 3 to learners.	Listen to teacher.
	4 min	Demonstrates measuring a desk to learners.	Watch teacher.
		Assists individual learners to measure their desk.	Measure desk individually.
	8 min	Collects measurements from class and writes measurements on board.	Provide measurements and listens to teacher.
		Asks learners questions about why they have different measurements for the same desk.	Answer teacher's questions.
		Explains why there are different lengths for different pencils and asks learners questions.	Listen and answer questions.
	6 min	Instructs learners to write a sentence about units of length.	Listen to instruction.
		Helps individual learners with sentence and marks learners' notebooks.	Write sentence in notebooks.
	2 min	Teacher listens to sentences and comments on them.	Learners read sentence.

Question 4 (19 min)	1,5 min	Reads question 4 from *Mfa7* LAB and explains the question to learners.	Listen to teacher and looks at the textbook.
	3 min	Asks learners what is the length of the matchstick on Thelma's ruler. Draws ruler and matchstick on the board. Asks learners what the length of the matchstick is. Asks learners to indicate whether they think the matchstick measures 4 or 5 'points'.	Individual learners answer question. Helps the teacher by calling out the numbers on the ruler as indicated in Mfa7 LAB. Individual learners answer question. Raise their hands to indicate whether they think the matchstick measures 4 or 5 'points'.
	3 min	Asks learners who said that the matchstick measures 4 points to demonstrate how they arrived at the answer and asks them questions at the board. Questions learners and establishes that some learners still think the matchstick measures 5 points.	Three learners demonstrate their answer while the rest of the class watches.
	4,5 min	Calls learner who says matchstick measures 5 'points' to the board to demonstrate his answer. Questions this learner about his age to demonstrate how to count on the ruler. Instructs learner to walk out steps on the floor to demonstrate to the rest of the class how to use a ruler. Demonstrates how to count the measurement of the matchstick on the ruler.	Learner demonstrates how he obtained his answer while the rest of class watches. Learner at board answers questions while the rest of the class watches. Class watches learner Class watches.
	7 min	Asks learners the length of the matchstick using Zulaigha's ruler. Draws ruler on the board. Asks learners what the matchstick measures. Draws matchstick on the board and calls learner to the board to demonstrate how she obtained her answer. Demonstrates how to measure the length of the matchstick and questions learners about the difference in the measurement of the matchstick with the different rulers.	Learners count the length from the diagram on the photocopied page. Class counts with teacher as she marks off the points on the ruler. A learner answers 7 and half. Class watches learner at the board. Class counts with the teacher as she demonstrates how to count on the ruler and individual learners answer questions.

Appendix 5.2:Day-to-day description of Mrs Tyandela's lessons

DATE	DESCRIPTION
02 Feb	Learners were given a table with 3 columns. The headings of the columns were weight (mass), length, liquids (capacity). Learners completed the table by entering the names of objects that would be measured by each of the form of measurement. The number of entries in each column differed from learner to learner.
03 Feb	The learner pasted a photocopy of page 66 of the *Maths for all* LAB in the notebook and wrote the answers to questions 1-3 of Activity 1 in the notebook.
08 Feb	The learner pasted a photocopy of page 67 of the *Maths for all* LAB in the notebook and wrote the answers to questions 5 a, b and c of Activity 2 in the notebook.
No date (question 3 was done on the day the lesson was recorded.(9 May Tuesday) So it appears as if the answers to exercise 1 took place over a number of lessons, at least 3 lessons	The learner pasted a photocopy of page 68 of the *Maths for all* LAB in the notebook and wrote the answers to questions from exercise 1. The following is written in this section of the notebook: a drawing of a quadrilateral that appears to be an answer to 1 (c), question 2 of Exercise 1, and a sentence which the teacher asked the learners to write about question 3
No date	Answer to question 4 (c) of Exercise 1. The learner pasted a photocopy of page 69 of the *Maths for all* LAB and a ruler she made in the notebook. The making of a ruler was the task of Activity 3.
18 May	The learner pasted a photocopy of page 70 of the *Maths for all* LAB in the notebook and wrote the answers to exercise 2 in the notebook.
No date	The learner pasted a photocopy of page 71 of the *Maths for all* LAB in the notebook and wrote the answers to questions 1 of Activity 4 in the notebook.
6 June	The learner pasted a photocopy of page 72 of the *Maths for all* LAB in the notebook and wrote the answers to questions 1-3 and 5 of Activity 5 in the notebook. The learner pasted a photocopy of page 74 of the *Maths for all* LAB in the notebook and wrote the answers to questions 2, 4 of Exercise 3in the notebook.
28 July	The learner pasted a photocopy of page 75 of the *Maths for all* LAB in the notebook and wrote the answers to questions 1 (a) and (b), Activity 6 in the notebook. The learner pasted a photocopy of page 76 of the *Maths for all* LAB in the notebook and wrote the answers to questions 2 of Activity 6 in the notebook.
31 July	The learner pasted a photocopy of page 78 of the *Maths for all* LAB in the notebook and wrote the answers to questions 2, 3, and 5 of Exercise 4 in the notebook.
08 Aug	Answers to question 6 of Exercise 4.

Appendix 5.3: Mrs. Nkosi's lesson outline

Tasks	Time	Teacher	Learners
Defining area and units of measurement.	6 min	Instructs learners to rub the cover of their exercise book. Defines area and writes definition on board. Asks questions about the shape of the book. Restates definition of area and instructs learners to point to surface of desk. Restates definition of area and instructs learners to point to surface of the board. Tells learners that unit of measurement for area is the square centimetre.	Rub the cover of books. Listen and watch teacher Answer questions by raising their hands. Point to surface of desk. One learner points to surface of the board. Listen and watches teacher
Recognition of shapes	3 min	Hands out *Mfa7* LAB textbooks Asks learners to identify shapes in Activity 6	Answer questions
Measuring blocks	2 min	Restates definition of area and unit of measurement and tells them there are rules for area. Instructs learners to measure blocks in rectangle 1.	Listens to teacher. Measure blocks in their groups.
Counting rows	5 min	Instructs learners to count number of rows in rectangle 1. Moves from group to group to assist learners with counting rows.	Count rows in their groups.
Counting 'blocks' (i.e. square cm units)	1 min	Instructs learners to count number of 'blocks' in rectangle 1.	Count 'blocks' in groups.
	4 min	Reads question 1 (a) of Activity 6 to class. Asks learners how are they going to calculate area of rectangle 1.	Listen to teacher. Discussing in groups.
Defining length and breadth	4 min	Tells them there is a rule for calculating area and reminds them about the unit of measurement. Tells learners to find area of a rectangle you have to measure the length and breadth of the rectangle. Asks learners to identify length and breadth of rectangle. Defines length and breadth and writes length and breadth on board.	Listen to teacher. Learner demonstrates what the length is by pointing in the teacher's book.
Measuring length and breadth (7 min)	1 min	Instructs learners to measure length and breadth of the rectangle. Defines length and breadth and writes the formula for area on the board.	Listen to teacher. Listen and watches board.
	4 min	Moves from group to check whether learners are measuring length and breadth of rectangle.	Measuring length and breadth of rectangle in groups.
	3 min	Records measurement of length and breadth on board by substituting into the formula.	Answer questions and listens.
Stating rules for area	4 min	Tells learners the rules for calculating the area of a rectangle. Asks learners to calculate 6cm X 4 cm.	Listen to teacher. Answers questions.
Rehearsing rules for area	3 min	Questions learners about the rules for calculating area of a rectangle.	Answer questions.
Calculate area of rectangle 3 and 4	5 min	Instructs learners to calculate area of rectangle 3 and 4 in groups.	Answer questions in their groups.
	6 min	Ask individuals to calculate answers on the board.	Watch learners calculate answers on the board.

Appendix 5.4: Day-to-day description of Mrs. Nkosi's lessons

Date	Description of entry in notebook
10 April	Heading 'Activity 1' The longest line Note: Direction ←Measurement →Length weight height Corrections done by teacher Learners answer questions of Activity 1, Chapter 4
14 April	Heading "Activity 2', Measuring length. Some learners do not answer the questions of this activity. The teacher does not mark it.
17 April	Heading Exercise Practice with units of length. Learners answer questions 1,2 & 3 of Exercise 1.
26 April	Learners answer question 4 of Exercise 1. Book signed by teacher but not marked.
2 May	Heading 'using millimetres and centimetres'. Learners answer exercise 2.
5 May	Learners answer questions 1 and 2 from Activity 4. Not marked by teacher
8 May	Notes taken down from board. Compare this to what teacher wrote. Area of a rectangle. Different learners have different answers in their books. From the video we know learners found the area of (iii) and (iv). The books show that learners did not know what is going on.
15 May	Note: different ways of writing the formula of perimeter Learners answer exercise 4, question 1.
16 May	Learners answer exercise 4, question 2
19 May	Learners answer exercise 4, question 6, 4 and question 2 of Activity 7
22 May	Learners answer exercise 4, question 5. Note on polyhedron and Volume.
23 May	Heading "activity 9, How big is a polyhedron' – only written in one book. Activity 8 written in another book. Looks like an attempt to teach these two activities was disbanded.
26 May	Heading' exercise 5, calculating the volume in cubic units'. Learners answer questions 1,2 and 3.
2 June	Heading 'exercise 6, calculating volume'. Learners answer question 1.

Appendix 6.1: Mr. Faku's lesson outline

Task	Time	Teacher	Learners
Answering question 8(d): Convert 56 cm to km	7 min	Writes heading 'corrections' on board. Calls learner to the board. Questions class about converting different standard units. Writes, explains and questions learners about conversion of standard units. Same learner called to 56 by 100 000 and questions learner about method of division. Calls learner to the board.	Class watches. Learner writes answer to question 8(d). Class choruses answers. Class responds to questions. Learner writes 0,00056 km in words.
Writing questions on board.	1,5 min	Writes question 9 (a) to (d) on the board.	Class assists teacher by calling out the questions.
Answering question 9 (a): i) Convert 7m to km ii) Convert 7m to mm	2,5 min	Confirms with class that the answer is correct and states that the number should become smaller because conversion is from m to mm. Questions class about the procedure for conversion.	Learner works out question 9(a) part 1on board: convert 7m to km. Learner works out 9 (a) part 2 on board: convert 7m to mm Class responds to questions
Answering question 9 (b: i) Convert 723m to km. ii) Convert 723m to cm	5 min	Questions learner to assist him to convert and asks the class when the learner is unable to answer	Learner works out answer to 9(b) part 1. Learner works out answer to 9(b) part 2.
Answering question 9 (c): i) Convert 7230m to km ii) Convert 7230m to cm	3 min	Questions whether answer is correct. Questions learner to assist to convert.	Learner works out answer to 9(c) part 1. Learner works out answer to 9(c) part 2. Second learner goes to board but correct answer. Third learner goes to board.
Answering question 9 (d): i) Convert 7 km to m ii) Convert 7 km to mm	4 min	Questions leaner to help him multiply 7 by 1000.	Learner works out answer to 9(d) part 1. Second learner comes to the board to work out answer. Learner answers 9 (d) part 2 correctly.
Explaining the homework task.	5 min	Hands out photocopied page (*Mfa7.4* LAB: 68). Asks learners to recognise shapes. Reads question 1 and explains question in Xhosa.	Answers questions. Listens to teacher.

Appendix 6.2 Day-to-day description of Mr. Faku's lessons

Date	Description
5 Apr	Learner pasted a photocopy of page 66 from *Maths for all.* Learners answered the questions 1-3 of Activity. This entry was headed 'Classwork'. Corrections done.
10 Apr	Learner pasted a photocopy of a textbook. Learners answered the questions on the photocopied page. This entry had no heading.
17 Apr	Learner pasted a photocopy of page from *Modern Basic Mathematics.* This was done under the heading 'Classwork'. Learners answered the questions 1 and 2 of exercise 6.1. Corrections done
19 Apr	5 answers written down but no exercise task. Learner pasted a photocopy of page from *Modern Basic Mathematics.* This was done under the heading 'Classwork'. Learners answered the questions 5 and 6 of exercise 6.2. Corrections done
26 Apr	Learner pasted a photocopy of page from *Modern Basic Mathematics.* This was done under the heading 'Classwork '. Learners answered the questions 7 and 8 of exercise 6.1. Corrections done
4 May	Learners answered the questions 9 of exercise 6.1. Corrections done.
5 May	Learner pasted a photocopy of page 68 from *Maths for all.* Learners answered the questions 1. This entry was headed 'Homework'. Corrections done.
8 May	Learners redid question 1 of Exercise 1 on page 68 of *Maths for all.*
9 May[1]	Heading 'notes'. Learner wrote down notes on perimeter.
11 May	Learner pasted a photocopy of page from *Modern Basic Mathematics..* This was done under the heading 'Homework '. Learners answered the question 1 of exercise 6.2. Corrections done.
12 May	Learners answered the questions 2 and 3 of exercise 6.2. This was done under the heading 'Classwork'. Corrections done. Corrected answer to question 3 is incorrect.
17 May	Learner pasted a photocopy of page from *Modern Basic Mathematics.* This was done under the heading 'Classwork'. Learners answered the question 5 of exercise 6.2. Corrections done
30 May	. Task and two worked examples was written at the back. The task involved a table headed 'length', breadth' and 'perimeter' and two of three measurements were given. Learners had to find the third measurement. The actual question is not in the notebook only the table with missing values.
2 June	8 sums where learners are given two of three measurements, length, breadth and perimeter and they have to find the third measurement. For example, B= 20 mm , S = 100 mm. There are no tasks in the notebook. From the learners answers I assume what the question was. Corrections done
7 June	Learner pasted a photocopy of page 72 from *Maths for all.* No heading 'Classwork'. Learners answered the questions Activity 5. Corrections done.
20 July	Learner pasted a photocopy of page from *Modern Basic Mathematics.* This was done under the heading 'Classwork'. Learners answered the questions Corrections done.
21 July	5 sums where learners calculated the area given the length and breadth. Question in notebook: 'Calculate area'. Task and worked example is written at the back of the notebook.
24 July	Learner pasted a photocopy of page from *Modern Basic Mathematics.* This was done under the heading 'Classwork'. Learners answered the question 2 Corrections done
26 July	Learner pasted a photocopy of page from *Modern Basic Mathematics.* This was done under the heading 'Classwork'. Learners answered the questions 8.

[1] Entry was at the back of the notebook.

Appendix 6.3 Mr. Mafilika's lesson outline

Task	Time	Teacher	Learner
Explaining the task.	2 min	Hands out photocopies. Reads and explains activity and instructs learners to work in groups.	Listen to instructions.
Comparing shapes on triangular and square grids.	7 min	Walks around ensuring that learners are working in groups. Stands against the wall reading. Explains to one group. After 6 min another group still does not understand the task which teacher explains.	Discuss question, which shape is bigger on each grid in groups.
Feedback on size of hexagon and star on triangular grids.	5 min	Reads question again to the class: which shape is bigger on the triangular grid? Assigns group names and writes group names on board. Ask groups for answers about which shape is bigger on the triangular grid and records answers on board. Asks groups to explain how they arrived at their answer and writes answer on board. Teacher works out answer publicly to verify learners' answer that the hexagon is bigger than the star.	Listens to teacher. Watches teacher and board. One member from each group answers. One member from each group answers. Listens and watches teacher.
Comparing size of rectangles on square grids	2 min	Asks learners to compare shapes on the square grid. Checks whether groups have completed task.	Listens to teacher. Work in groups.
Feedback on size of shapes on square grids	3 min	Asks groups for answers and writes on board.	One member from each group answers. All the groups say the top rectangle is bigger.
Finding perimeter of shapes on triangular grid	3,5 min	Asks learners to find out which shape has a bigger perimeter. Walks around to each group to collect answer.	Listens to teacher and then discuss question in groups. One member from each group answers.
Finding perimeter of rectangles	3 min	Teacher calculates perimeter of the rectangles for the class.	Watches and answers teacher's questions about the calculations as a class.
Finding area of the shapes	2 min	Asks learners to find the area of the rectangles to check whether areas are equal. Teacher writes answer on the board. Asks learners to find out which figure on the triangular grid is the bigger in terms of area. Reading photocopied page. Teacher appeared to be working out the answers to the tasks. Writes answer on board. Defines perimeter and area.	Discuss in groups. Answer teacher's question. One member from each group answers. Discuss in groups. Answer teacher's question Listens to teacher.
Drawing grids	5 min	Asks learners to draw grids that are not triangular or square i.e. to answer question 5 (a) of Activity 5. Hands out squared paper Re-explains task Reads question 5 (a) and then tells learners to skip question. Reads question 5(b) – drawing a 3-sided and five sided figure on a grid. (this is not completed in class).	Listens to teacher. Learners appear not to know what to do. Listens to teacher. Discuss in groups.

Appendix 6.4:Day-to-day description of Mr. Mafilika's lessons

Date	Description
18 April	Worked example: A square with side = 8 and diagonal = 12 was provided. The task was to calculate the perimeter of the two triangles formed by the diagonal
19 April	Worked example: Calculate perimeter of L-shaped figure with the dimensions provided. Another L-shaped figure given as classwork.
25 April	Three L-shaped figures. Learners have to calculate perimeter.
3 May	Worked example: 6 by 6-square grid provided. Calculation of area done. Four problems with square grids on area of rectangles given as classwork.
9 May	Finding area of rectangles without square grids. Four problems given as classwork
10 May	Finding area of rectangles given the dimensions of rectangle. Learners expected to draw rectangles. Four problems given
23 May	Finding area of L-shaped figure.
30 May	Finding area of L-shaped figure.
6 June	Finding area of H-shaped figure.
7 June	Drawing of rectangle with dimensions provided and rectangle divided by diagonal. Assume that example was used to show that area of triangle = ½ X base X height. Two worked examples provided and three problems given as classwork/ homework.

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