# An investigation into how Mathematics educators teach the outcomes-based curriculum

by

Vasanthy Velupillai

Submitted in partial fulfilment of the requirement for the degree

Magister Scientiae

in the Department of Mathematics and Applied Mathematics
in the Faculty of Natural and Agricultural Sciences

University of Pretoria
Pretoria

October 2006

## ACKNOWLEDGEMENTS

My sincerest gratitude to the following people for their assistance with this dissertation:

**Prof. Johann Engelbrecht and Dr. Ansie Harding**, my supervisors, for their patience and kindness, invaluable guidance and assistance, constructive recommendations to develop my ideas, support so necessary to make this task a success.

**Prof. John Rogan** for his encouragement, invaluable guidance, assistance and constructive recommendations to develop my ideas, for always being there for me, and particularly for allowing me use the data collected by the MSSI project staff.

**Dr. Loyiso Jita** for his encouragement and being instrumental in removing my fear of writing.

**Dr. Aria Merkestein** for proof reading and language editing.

In my family my thanks go to:

My husband **Nadarajah Velupillai** and my sons **Harry Mayuran** and **Vimalan** for their unwavering support.

My late father **Sabapathy Namasivayam** and my mother **Ratnam Namasivayam**.

And lastly and most importantly I thank **God** for his/her blessing.

# LIST OF ABREVIATIONS AND ACRONYMS

| | |
|---|---|
| **NCTM** | National Council of Teachers of Mathematics |
| **OBE** | Outcomes Based Education |
| **SO** | Specific Outcomes |
| **DET** | Former Department of Education and Training |
| **GET** | General Education and Training |
| **FET** | Further Education and Training |
| **MLMMS** | Mathematical Literacy, Mathematics and Mathematical Sciences |
| **MSSI** | Mpumalanga Secondary Science Initiative |
| **NQF** | National Qualification Framework |
| **JICA** | Japanese International Cooperation Agency |
| **TIMSS** | Teacher Questionnaire of the Third International Mathematics and Science Study |
| **NCEA** | National Certificate of Educational Achievement |
| **USA** | United States of America |

# DEFINITION OF CONCEPTS

**OBE**: Outcomes-Based Education (OBE) is a learner-centred, result-orientated approach premised on the belief that all learners can learn and succeed.

**Standards**: Standards are verbal statements of goals or desired classes of outcomes.

**Educator**: An educator is any person who teaches, educates or trains another person. In this study the terms 'educators', 'facilitators' and 'teachers' are used interchangeably.

**GET**: General Education and Training (GET) includes learning programmes that are registered at NQF level 1 and that correspond to Grades R to 9 in the old South African school education system.

**FET**: Further Education and Training (FET) includes learning programmes that are registered at NQF levels 2 to 4, and that correspond to Grades 10 to 12 in the old South African school system, and N1 to N3 in the old South African technical college education system.

**NQF:** National Qualification Framework (NQF) is a framework approved by the Minister of Education, South Africa, for the registration of national standards and qualifications in the education and training system.

## ABSTRACT

This study investigates how educators at General Education and Training (GET) level (senior phase) go about teaching problem solving skills, reasoning and communication as indicated in the OBE Mathematics curriculum (GET).

In comparison to previous curricula, the new Outcomes-Based Education (OBE) Mathematics curriculum at the GET level, places more emphasis on problem solving, reasoning and communicating mathematical ideas. If properly implemented as intended by the curriculum reformers, then many of the problems that are encountered at tertiary level might no longer exist. Thus it is interesting to investigate how educators at GET level go about teaching such skills as problem solving, reasoning and communication as indicated in the OBE Mathematics curriculum at GET level.

This study describes case studies of Grades 8 and 9 Mathematics teachers in eleven secondary schools in Mpumalanga Province in South Africa. The case studies explore whether and how the mathematics teachers go about trying to achieve the outcomes mentioned in the OBE (GET) Mathematics curriculum. The educators' pedagogical methods are investigated, and, generally, how well the learning outcomes are achieved. A third research strand focuses on whether there exists a relationship between the teachers' contribution (input), which is the foundation laid by the teacher for the later realisation of outcomes and outcomes as attempted or demonstrated by learners. The data were collected through video-tape recordings by trained educators, that is, Mpumalanga Secondary Science Initiative (MSSI) project staff to ensure authenticity and credibility of results.

# TABLE OF CONTENTS

**ACKNOWLEDGEMENTS**……………………………………………………………...ii

**LIST OF ABREVIATIONS AND ACRONYMS**……………………………..…….iii

**DEFINITION OF CONCEPTS**……………………………………………………iv

**ABSTRACT**………………………………………………………………………….v

**CHAPTER ONE: BACKGROUND**

1.1 Introduction…………………………………………….………………..1

1.1.1 Background to the study………………………………..……………..1

1.1.2 The South African school system.…..………………………..….……….2

1.1.3 Concerns of South African educators……………………………………4

1.2 The context……………………………………………………………5

1.3 The importance of the study………………………………………………..5

1.4 Objectives and research questions..…………………………………...6

1.5 Research methodology………………………………………………...7

1.6 Structure of the dissertation …………………………………………..7

1.7 Summary…...……………………………………………………………8

**CHAPTER TWO: LITERATURE REVIEW**

2.1 Introduction……………………………………………………………9

2.2 What is outcomes-comes based education?…………………………...9

2.3 Curriculum reform towards outcomes-based education……………………..13

2.4 Strength in different teaching methods………..…………….…………14

2.5 Strengths in outcomes – based education..…………...……………………..15

2.6 Reasons for failed curriculum and poor outcomes…………………………..19

2.7 Divisions in society……………..……………...……………..…………20

2.8 Conclusion………………………………………………………………...20

## CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction……………………………………………………………………..22
3.2 Subject of the research……...…..…………..………………………………….22
3.3 Data capturing…………………………………………………………………..23
3.4 Design for data analysis………………………………………………………...25
3.5 Procedure……………………………………………………………………….26
3.6 Conclusion……………………………………………………………………...29

## CHAPTER FOUR: BREAKDOWN OF LESSONS WITH RESPECT TO LEARNING OUTCOMES AND TIME ALLOCATION

4.1 Introduction……………………………………………..…………………….30
4.2 Results based on the lessons observed……………………………………..…30
4.2.1 Lesson No 1……………………………………………………………….…30
4.2.2 Lesson No 2……………………………………………………………….…33
4.2.3 Lesson No 3……………………………………………………………….…36
4.2.4 Lesson No 4……………………………………………………………….…38
4.2.5 Lesson No 5……………………………………………………………….…41
4.2.6 Lesson No 6………………………………………………………………….43
4.2.7 Lesson No 7………………………………………………………………….46
4.2.8 Lesson No 8………………………………………………………………….48
4.2.9 Lesson No 9…………………………………………………….……………50
4.2.10 Lesson No 10…………………..………………………………………………53
4.2.11 Lesson No 11……………………………………………………………...55
4.3 Specific outcomes……………………………………………………………57
4.3.1 SO1…………………………………………………………………………..57
4.3.2 SO2…………………………………………………………………………..58
4.3.3 SO3…………………………………………………………………………..58
4.3.4 SO4…………………………………………………………………………..58
4.3.5 SO5…………………………………………………………………………..59
4.3.6 SO6…………………………………………………..……….……...59
4.3.7 SO7…………………………………………………………………………..59

4.3.8 SO8……………………………………..…………………………....60
4.3.9 SO9…………………………………………………………………..60
4.3.10 SO10…………………………………………………………………60
4.3.11 Specific outcomes summary…………………………………………61
4.4 Teacher's contribution and learners' achievement……………..………...62
4.5 Conclusion…………………………..……………………………..………64

**CHAPTER FIVE: QUALITATIVE REPORT ON CLASSROOM OBSERVATIONS**

5.1 Introduction………………………………………….…………………….65
5.2 General observations (observations concerning all lessons)……….……..…65
5.3 Specific observations in lessons……..……………………….………………69
5.3.1 Lesson No 1..………………...……………………………...…..………..…69
5.3.2 Lesson No 2..…………………..…………………...……..…….………71
5.3.3 Lesson No 3..………………..……………………………...…..…..…………74
5.3.4 Lesson No 4..………………..…………………………...…..……………..…76
5.3.5 Lesson No 5..…………………..……………………...…...……………78
5.3.6 Lesson No 6..………………………..………………...…...……………80
5.3.7 Lesson No 7..………………………..………………...……..…………82
5.3.8 Lesson No 8..………………………..…………………...…………….84
5.3.9 Lesson No 9..………………………..……………….....….……………..85
5.3.10 Lesson No 10………………………..……………...….………………..87
5.3.11 Lesson No 11…………………..……………………...….………………..88
5.4 Conclusion……………………………………………………………...90

**CHAPTER SIX: FINDINGS AND CONCLUSIONS**

6.1 Introduction……………………………………………….………………….91
6.2 Findings………………………..…………………………….………………91
6.2.1 To what extent are the mathematics learning outcomes mentioned in the intended Curriculum 2005 attempted by the learners and/or by the educators?..........................................................................................…..91

6.2.2 Is there any relationship between teachers' contribution (input), which is the foundation laid by the teacher for the later realisation of outcomes, and outcomes as attempted or demonstrated by learners?…………………..94

6.2.3 What kinds of teaching strategies are used in attempting to achieve the learning outcomes?………..…………………………………………………………..94

6.3 Conclusions of the study……………………..……………………….……..…..97

6.4 Recommendations……………………………………..…..……………. 100

6.5 Issues for further research………………………………………….…….100

6.6 Limitations of the study……………..……………..………………..……101

6.7 Conclusion of the chapter….……………………..…..……..……………101

**BIBLIOGRAPHY**……………………………………………………………102

**LIST OF APPENDICES**

Appendix A…………………………………………………………………109

Appendix B…………………………………………………………………110

Appendix C…………………………………………………………………111

Appendix D…………………………………………………………………112

# CHAPTER ONE

# BACKGROUND

## 1.1 Introduction

### 1.1.1 Background to the study

The Department of Education in a document on the National Curriculum Framework, (Department of Education, 1997) which is based on principles set out in the White Paper on Education and Training (Department of Education, 1995) emphasises the need for changes in education and training in South Africa in order to normalise and transform teaching and learning processes. The document furthermore mentions that the changes would make education interesting, understandable and relevant to all learners, and would cause learners to acquire knowledge, skills as well as desirable attitudes and values.

Educators who believe in outcomes-based education argue that a shift away from the traditional aims-and-objectives approach to outcomes-based education (OBE) is a necessary prerequisite for a prosperous, truly united, democratic and internationally competitive South Africa (Department of Education, 1995). They furthermore argue that the traditional aims-and-objectives approach produces passive learners. Because of this need for change, the Department of Education (1997) proposed to adopt outcomes-based education, by means of Curriculum 2005, which was to be introduced into the General Education and Training (GET) band from 1997 onwards.

The question here is not whether OBE is a good option for training and education, rather the question is how well it needs to be implemented in order to provide essentially the same quality of learning opportunities to all South African citizens, so enabling them to achieve the outcomes mentioned in Curriculum 2005.

### 1.1.2 The South African school system

The GET (General Education and Training) band is divided into three phases: the Foundation Phase, which spans Grades R-3 of Primary Education, the Junior Phase, which spans Grades 4-6 of Primary Education, and the Senior Phase that spans Grades 7-9 and is the last phase of the GET band. At present, the Senior Phase (in GET) is divided between primary and secondary school. Grade 7, although part of the Senior Phase still falls under Primary Education. Grades 8 and 9 fall under Junior Secondary Education. Grades 10, 11 and 12 fall under the FET (Further Education and Training) band, the last stage of Secondary Education. See Figure 1.1.2.

This study focuses on Grades 8 and 9 of the Senior Phase. For Curriculum 2005, the learning content offered in the Senior Phase should be less contextualised, more abstract and more area-specific, than in the previous two phases (Department of Education, 1997). NCTM (National Council of Teachers of Mathematics) Standards have suggested that in the Senior Phase, learners should build on more sophisticated problem-solving techniques and should increase their ability to visualise, describe, and analyse situations in mathematical terms. By the time learners finish the Senior Phase, they should, to a great extent, be able to reason independently, without the aid of concrete materials or experience. In addition, they should have learned to engage in open argument and be willing to accept multiple solutions to single problems. Since at the time of this study only the GET band had been implemented, this study is limited to an investigation of mathematics teaching practices in the Senior Phase and focuses on Grades 8 and 9.

During the Senior Phase learners should be able to construct their own understanding of each mathematical concept. Thus, the primary role of teaching is not to lecture, explain or otherwise attempt to "transfer" mathematical knowledge, but to create situations for learners that foster opportunity to make the necessary mental constructions. It is important, therefore, for learners to focus on critical and creative thinking skills, attitude development and the understanding of their role in society. The most in-depth development of logical and intellectual cognitive and meta-cognitive skills takes place during the Senior Phase.

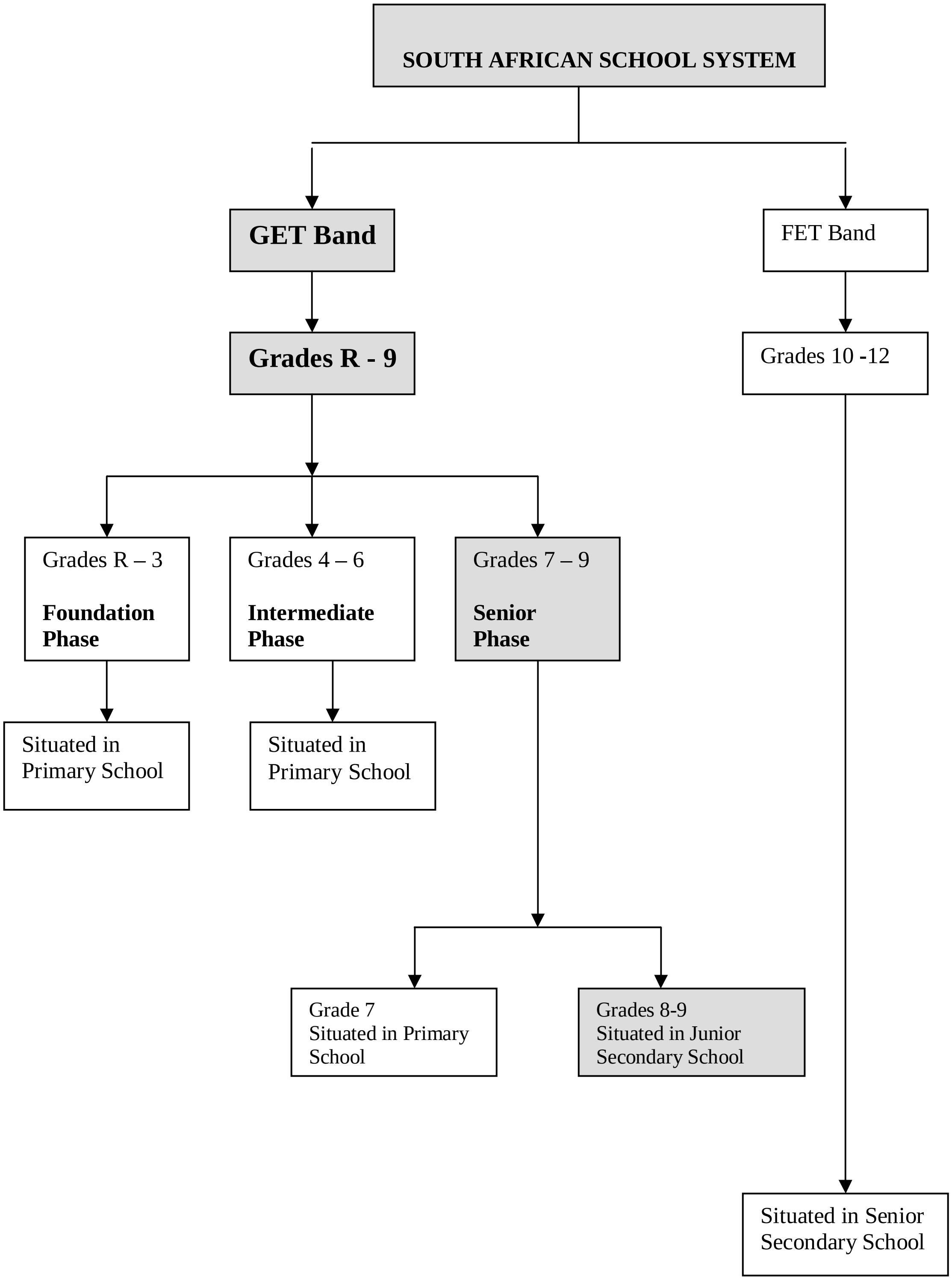



Figure 1.1.2

The National Curriculum 2005 policy document identifies eight learning areas for the Senior Phase. One of them is titled Mathematical Literacy, Mathematics and Mathematical Sciences. The following ten specific outcomes are mentioned for this learning area:

SO1. Demonstrate understanding about ways of working with numbers.

SO2. Manipulate number patterns in different ways.

SO3. Demonstrate understanding of the historical development of mathematics in various social and cultural contexts.

SO4. Critically analyse how mathematical relationships are used in social, political and economic relations.

SO5. Measure with competence and confidence in a variety of contexts.

SO6. Use data from various contexts to make informed judgements.

SO7. Describe and represent experiences with shape, space, time and motion, using all available senses.

SO8. Analyse natural forms, cultural products and processes as representations of shape, space and time.

SO9. Use mathematical language to communicate mathematical ideas, concepts, generalisations and thought processes.

SO10. Use various logical processes to formulate, test and justify conjectures.

Educators act as facilitators in helping learners achieve the above specific outcomes. Therefore, in the Senior Phase, the pedagogical knowledge and content knowledge of mathematics teachers are crucial.

### 1.1.3 Concerns of South African educators

Lack of resources, for example in materials and classrooms, and there is a shortage of trained teachers, particularly in mathematics and science, have caused many educators to be concerned that the OBE curriculum cannot be successfully implemented. Muller (1998), for example, claims that the curriculum reform initiated in South Africa embodies incompatible logics, which can only lead to confusion. Jansen (1998) points out ten reasons why OBE would fail in South Africa. Some of the reasons are based on the language of innovation associated with OBE, the management of OBE, requirement of trained and retrained teachers. Rogan (2004, p172) asks the question “Are we jumping from one frying pan into another frying pan for the sake of changing?”. In his case study he viewed eighteen videotaped science lessons from MSSI (Mpumalanga Secondary Science Initiative) project schools in Mpumalanga Province. He found that the four science specific outcomes out of nine were attempted or achieved in these eighteen lessons. He further mentions that the teachers and learners spent time mostly on specific outcomes one and two.

## 1.2 The context

The study was conducted in eleven Grade 8 and 9 classes in the Mpumalanga Province during 2002, where OBE has been followed since 1999. This study analyses the success of the attempt by the learners and/or educators to address the outcomes as mentioned in the OBE mathematics curriculum. The study also attempts to analyse the pedagogical methods of the teacher (facilitator), which of the learning outcomes are attempted, whether the learners are given enough time to address those outcomes, and whether there is any relationship between teachers’ input and learners’ addressing of outcomes.

## 1.3 The importance of the study

In my experience, teaching mathematical subjects to first-year learners at a higher education institution is generally difficult because of their lack of skills with regard to problem solving, reasoning and communicating mathematical ideas. The learners cannot be blamed, because, traditionally in the South African context doing mathematics is associated with following the teacher’s rules (Department of Education,1997). In the words of Grouws & Schultz (1996), traditionally, knowing mathematics means remembering and applying the correct rules and having the answer ratified by the teacher. The OBE view of mathematics is very different and although it includes rules and applications, it is much broader and features other mathematical knowledge and processes, including problem solving, analysing, and reasoning (Grouws & Schultz, 1996). While teachers traditionally concentrate on procedural mathematical knowledge, in OBE teachers need to concentrate on principled mathematical knowledge. According to Lampert (2001) teaching is a dynamic process of work rather than the more static process of applying knowledge. For South Africa to succeed in the 21st century, learners have to be able to apply knowledge by creating, designing, producing and performing, and to tap into more complex thinking and problem-solving skills required in real-life applications (Department of Education, 1997). The ideal is that if the OBE mathematics curriculum is implemented properly throughout the GET (and FET) phase, future learners at institutions of higher education should be better equipped to master mathematical subjects.

How do we know, however, whether and how much teachers, actually, focus on achieving the outcomes associated with problem solving, analysing, and reasoning knowledge, which are topics crucial to be successful in mathematical subjects at tertiary level? This study addresses this question, formulated in more detail below.

The study determines whether teachers are concentrating on and achieving the outcomes as set in the Senior Phase of Curriculum 2005. In particular, attention is given to whether educators provide learners with opportunities to master principled mathematical knowledge.

This study does not answer questions about what teachers should know or should not know; it will attempt to examine how the OBE mathematics curriculum (GET level) is followed.

## 1.4 Objectives and research questions

Barwell (2000) uses a three-part model of the curriculum to characterise the teaching and learning process.

- The *intended curriculum* refers to what teachers are expected to teach.

- The *implemented curriculum* refers to the result of the intended curriculum being put into practice.
- The *achieved curriculum* refers to what learners learn, having experienced the implemented curriculum.

The achieved learning outcomes clearly depend on the implemented curriculum, not on the intended curriculum. After all, what learners learn depends on what happens in the classroom.

The specific research questions that guide the analyses are:

- To what extent are the mathematics learning outcomes for Grades 8 and 9 mentioned in the intended Curriculum 2005 addressed by the learners and/or by the educators?
- Is there any relationship between teachers' contribution (input), which is the foundation laid by the teacher for the later realisation of outcomes, and outcomes as attempted or demonstrated by learners?
- What kinds of teaching strategies are used in attempting to achieve the learning outcomes?

## 1.5 Research methodology

In this study a combination of a qualitative and a quantitative approach was followed. The data used in this study were captured by staff of the Mpumalanga Secondary Science Initiative (MSSI) Project. Most of the schools taking part in this project are situated in rural areas and have a history of shortage of resources. The learners in the schools mostly come from historically disadvantaged backgrounds.

## 1.6 Structure of the dissertation

The dissertation is structured as follows:

Chapter 1 deals with the background of the study, the importance of the study, and explains the research questions.

Chapter 2 provides a brief summary of the literature on OBE curriculum reform in this and other countries, its strengths and weaknesses in terms of outcomes and how this affects society.

Chapter 3 explains the research methodology: How was the data collected? Where was the data collected? How was the data analysed?

Chapter 4 gives a detailed breakdown of lessons with respect to learning outcomes and time allocation.

Chapter 5 gives a detailed qualitative report on classroom observations in general and specific to each lesson observed.

Chapter 6 gives an overview of the findings, presents recommendations and limitations of the study.

### 1.7 Summary

In this chapter the background to the study, the problem statement and importance of the study are outlined. The aims and objectives of the study are clearly defined. An overview is given of the structure of the dissertation.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

A literature review is one means of acquiring information regarding the wider context and background to the research topic, as well as information regarding related studies carried out on similar topics. The literature review, for instance, assisted the researcher in acquainting herself with the improvement in learning-skills, technologies and approaches after outcomes-based education had been implemented in other countries.

This chapter provides a brief summary of the literature on educational reform aiming at the implementation of outcomes-based education, the strengths and weaknesses in achieving the desired learning outcomes in developed countries, in what way teaching methods have changed when implementing OBE and the effect of OBE on society. Based on the available literature, the chapter attempts to illustrate what differences in teaching methodologies and strategies, in South Africa and elsewhere, have been prompted by the introduction of outcomes- based education.

## 2.2 What is outcomes- based education?

OBE is a learner-centred, result-orientated approach premised on the belief that all learners can learn and succeed. Spady (1994), who is widely regarded as the architect of OBE, states that following outcomes-based education means focusing and organising a school's entire program and instructional efforts around the clearly defined outcomes that all learners need to demonstrate when they leave school.

Concerns that the education system cannot adequately prepare learners for life and work in the 21$^{st}$ Century have prompted people to explore new ways of designing education

(Education Commission of the States, 1995). One such a design is outcomes-based education.

OBE is a method of curriculum design and teaching that focuses on what learners can actually do after they have been taught (Acharya, 2003). OBE addresses the key questions such as:

a) What do you want the learners to learn?

b) Why do you want them to learn it?

c) How can you best help learners learn it?

d) How will you know what they have learnt?

Thus, the OBE's instructional planning process is a reverse of that associated with traditional educational planning. The desired outcome is selected first and the curriculum, instructional materials and assessments are created to support the intended outcome. All curriculum and teaching decisions are made based on how best to facilitate the desired final outcome.

Towers (1996) lists four points to the OBE system that are necessary to make it work:

a) What the learner is to learn must be clearly identified.

b) The learner's progress is based on demonstrated achievement.

c) Multiple instructional and assessment strategies need to be available to meet the needs of each learner.

d) Adequate time and assistance need to be provided so that each learner can reach the maximum potential.

According to Acharya (2003) the four basic principles of OBE are:

a) Clarity of focus about outcomes

- Always have the significant, culminating exit outcomes as the focus.
- Let the learners know what they are aiming for.

b) Designing backwards

- Design curriculum backward by using the major outcomes as the focus and linking all planning, teaching and assessment decisions directly to these outcomes.

c) Consistent, high expectations of success

- Set the expectation that OBE is for ALL learners.
- Expect learners to succeed by providing them encouragement to engage deeply with the issues they are learning and to achieve the high challenging standard set

d) Expanded opportunity

- Develop curriculum to give scope to every learner to learn in his/her own pace.
- Cater for individual needs and differences, for example, expansion of available time and resources so that all learners succeed in reaching the exit outcomes.

According to the Education Commission of the States (1995) the shift toward outcomes-based education reflects a belief that the best way for individuals and organisations to get where they are going is first to determine where they are and where they want to be - then plan backwards to determine the best way to get from here to there. They list the following arguments against and for outcomes-based education:

| **Common Arguments in Favour of Outcomes-Based Education.** | **Common Arguments Against Outcomes-Based Education.** |
|---|---|
| Promotes high expectations and greater learning for all learners. | Conflicts with admission requirements and practices of most colleges and universities, which rely on credit hours and standardised test scores. |
| Prepares learners for life and work in the 21st Century. | Some outcomes focus too much on feelings, values, attitudes and beliefs, and not enough on the attainment of factual knowledge. |
| Fosters more authentic forms of assessment i.e., learners write to show they know how to use English well, or complete math problems to demonstrate their ability to solve problems. | Relies on subjective evaluation, rather than objective tests and measurements. |
| Encourages decision making. | Undermines local control. |

Outcomes-based education is the forerunner of the standards-based education reform, both originating in the United States and based on similar beliefs (Wikipedia, 2006). In the United States, the term OBE and many of the original practices have fallen out of favour. OBE has been referred to by over 20 different names including Systemic education restructuring, performance-based education, standards-based education reform, high performance learning, total quality management, transformational education, competency-based education, and break-the-mould schools. The names have been changed largely due to strong negative responses to these programmes. It has evolved from OBE to performance based education in the early 1990s, Goals 2000, and in the 2000s, standards-based education reform legislation such as No Child Left Behind.

Nearly all USA states and public school districts today have curriculum frameworks, learning outcomes, standards, and goals characteristic of OBE (Wikipedia, 2006).

The following quote, taken from the editorial writing in Plato magazine (August, 2005), paints a bleak picture of OBE:

> OBE represents an experimental approach to education that has only been adopted by a handful of overseas countries, including: the USA, South Africa, Canada, New Zealand and England. The USA has rejected OBE in preference for standards, South Africa's implementation of OBE has failed, England has significantly modified its OBE approach and, in New Zealand, there is widespread public concern over that country's new senior school certificate – the NCEA which is very similar to the proposed Western Australian certificate.
>
> Those countries that regularly outperform Western Australian learners in maths and science tests (TIMSS and TIMSS-R) have never experimented with OBE. Countries like Japan, Singapore, South Korea, the Netherlands and the Czech Republic have a syllabus approach to curriculum – the opposite to OBE.

*2.3 Curriculum reform towards outcomes- based education*

OBE in its most essential form can be thought of as a form of education that makes the goals or objectives of a course and each of its units explicit, so that each learner understands these. It also makes explicit what each learner should understand and be able to do at the exit level and during the intervening stages (Treloar, 2002). Treloar (2002) focused on Australia, which, between 1987 and 1993, embarked on a flurry of educational reforms. Currently, in Australia, OBE permeates the entire educational system, from the level of Kindergarten up to Year 12.

Barcan (2001) states that outcomes-based education is one of the numerous educational initiatives that have proliferated over the last two decades. He further states that

Tasmania contributed "Key Intended Learning Outcomes", Victoria its "Curriculum and Standards Frameworks", and Western Australia its "Outcome Statements".

Rowe (1994) views OBE as a practical way of organising a school poised to achieve improved performance both in the organisation as a system and the people within it, so that all conditions reinforce each other, thus enhancing quality.

Donnelly (2002) mentions that the curriculum designers describe the New Zealand model as being “learner-centred”, “process-based” and embodying an “ outcomes-based” approach. He further mentions that the education authorities in Asia, for instance in Hong Kong and Singapore, are, despite their successful systems, so impressed by the New Zealand education system that they are abandoning the approaches in their own syllabi in favour of OBE**.**

In the USA, curriculum and evaluation standards (NCTM, 1989) and subsequent teaching documents (NCTM, 1991) and assessment documents (NCTM, 1995) set the stage for sweeping changes in the type of mathematics to be taught, and the manner in which it should be taught and assessed (Lappan, 1999). The NCTM Standards recommend that the curriculum should place an emphasis on problem solving, reasoning, making connections between mathematical topics, communicating mathematical ideas and providing an opportunity for all to learn (NCTM, 1989, 1991, 1995, 2000). Riordan and Noyce (2001) mention that standards-based programmes are written specifically to fulfil, not only the content standards, but also the pedagogical approaches that the standards advocate. The NCTM has remained committed to the view that standards should play a leading role in guiding the improvement of mathematics education. King and Evans (1991) mentioned in their study that outcomes-based education seems to provide a ready answer to the question of what can be done to reshape America’s schools for the 21$^{st}$ century. This has since been proven not to be the case.

*2.4 Strength in different teaching methods*

Standards-based education suggests that the learners should first understand the procedures before practising them. It is further suggested that learners should apply those procedures in their daily lives.

The traditional way of learning mathematics is through repeated exercises. Teaching mathematics has, therefore, been based on teaching the steps to do the exercises. According to Hiebert (1999), the issue whether learners should first practise procedures and then try to understand them, or understand procedures before practising them is still under debate. He points to evidence given by Brownell and Chazal (1935), Mack (1990) and Wearne and Hiebert (1988) that, if learners memorise procedures and then practise them over and over, they find it difficult to understand those procedures at a later stage**.** Standards-based curriculum programmes in the USA place less emphasis on memorising and manipulating numbers (e.g. long division, factorising polynomials) (Goldsmith, Mark and Kantrov, 1998).

***For learners to develop a deep understanding of these procedures, teachers need to use different teaching methods. The relationship between different teaching methods and learners' understanding of mathematics has fascinated both teachers and researchers for decades (Benezet, 1935). OBE, for example, encourages teachers to choose different methods in their classes. There are various teaching methods that can be used in the Senior Phase to help learners gain knowledge to achieve specific outcomes mentioned in Curriculum 2005, such as the discussion method, the project method, the textbook method, the discovery method, the cooperative method, and the question and answer method.***

***Jacobs, Gave and Vikalisa (2000) state that for outcomes to be achieved, the educator needs a procedure to guide the learners. They further state that success is determined by the motivation and efforts of the teacher. Not only does OBE encourage learners to choose different ways to solve the mathematics problems, but also to combine them, discuss them with their peers.***

*2.5 Strengths in outcomes-based education*

Extensive research has been conducted on how OBE or standards-based education (SBE), improves mathematics understanding. I mention some of them below.

A study done by Riordan and Noyce (2001) in the USA shows that standards-based mathematics programmes have a positive impact on learner achievement. The gain in learner performance was greater in schools that implemented standards-based programmes compared to schools that did not. Those gains, although moderate in size, remained consistent for different groups of learners, right across mathematical topics and different types of mathematics-related questions. Riordan and Noyce furthermore mention that, generally speaking, the standards-based curriculum can make a significant contribution to improving learners' learning in mathematics.

Hiebert (1999) claims that the standards proposed by the NCTM are, in many ways, more ambitious than those of traditional mathematics programmes. On the basis of beliefs about what learners should know and be able to do, these standards include conceptual understanding and the use of key mathematical processes, as well as skills proficiency. Hiebert postulates that evidence indicates that most traditional programmes do not provide learners with many opportunities to achieve those additional goals – as identified by the NCTM – and, not surprisingly, most learners do not achieve them. He furthermore mentions that in Standards-Based Education (SBE) the learners learned more deeply than in traditional programmes, and also that standards-based programmes can facilitate both the development of conceptual understanding and procedural skills.

In research done for the Department of Education, University of Minnesota (USA), King et al. (1992) found that standards-based programmes taught at 37 schools, in 1990 and 1991, had three perceived effects on learner learning. Forty-nine per cent of teachers reported more and better learning. ("I've gotten a lot more out of class than the last few years." "There's been a tremendous increase in learner learning." "We have set higher expectations, and learners are achieving more.") Forty-three per cent of teachers reported increased learner involvement in learning. ("Kids really take a stake in learning and are more responsible. I'm pushing myself more.") Thirty-five per cent of teachers reported different effects for different learner types. Many parents expressed a sense that OBE "works for the average and unmotivated learner," because such learners are allowed sufficient time and opportunities to succeed, and because of OBE some learners have become part of a regular instructional programme for the first time.

In three studies in the USA, Mokros (2002) posed word problems involving operations (in my experience this is the main problem for the majority of South African learners), and examined the accuracy and effectiveness of participants' methods of solving those problems. Based on her studies, she states that learners in the *Investigations* groups (one of the successful teaching strategies in OBE) performed better than their counterparts in other curricula with respect to word problems. They used more complex calculations embedded in word problems, and tackled problems that involved explaining how an operation worked. For example, *Investigations* learners generated more sophisticated solutions when asked to write number sentences. *Investigations* learners were also more successful in solving word problems to which there were multiple solutions and to which the choice of operations was not obvious, such as specifying the ages of four people in a family whose ages totalled a given number. Moreover, *Investigations* learners showed deeper conceptual understanding when solving multiplication problems and explaining how the solution to one problem helped them to solve a related problem. Besides being more accurate in solving complex problems, learners in the *Investigations* groups showed qualitatively different ways of thinking about the operations compared to learners in other groups. The procedures *Investigations* learners employed showed that they had an understanding of the meaning of an operation, of the structure of multiplication and division, and of place value.

Standardised tests conducted by the ARC Center Tri-State Student Achievement Study (2000) in Elementary Schools in Massachusetts, Illinois, and Washington State show that learners in schools using the standards-based material consistently score higher than learners in the matched comparison groups. The results hold across all racial and income groups. The findings also support the results held across the different state-mandated tests, including the IOWA Test of Basic Skills, and across topics ranging from computation, measurement and geometry, to algebra, problem solving, and making connections.

In North Carolina (USA), a standards-based system was implemented with rigorous internationally benchmarked assessments. In the following year, North Carolina posted greater gains in learner achievement than any other state in the USA (Reys, Reys, Lapan, Holliday and Wasman, 2001)

In Missouri (USA), in the first of three districts where standards-based curricula were introduced as a pilot study, all of the significant differences reflected a higher achievement among learners who were using standards-based materials (Reys et al., 2001).

It is a well-documented opinion that outcomes-based learning improves the learning of mathematics (Geddert, 1993; Mason, 1998). Standards-based teaching practices positively influence the science achievements and attitudes of urban African-American learners (Kahle, Meece and Scantlebury, 2000).

In a standards-based curriculum, learners are often asked to work in small groups, to come up with alternative methods for solving problems, and to describe their reasoning, verbally, in writing, and through multiple representations (e.g. charts, tables, diagrams). Learners tend to work on fewer but more complex problems than posed in a traditional curriculum, with the problems often being based on real-life situations and applications. Basic skills practice tends to be embedded in real-life problems and basic skills are practised in games and activities (Goldsmith et al., 1998). The concept of team learning and team teaching is one of the successful teaching strategies in OBE. Cooper (1995) suggests that group learning could promote critical thinking. University learners involved in team learning have identified a strong sense of teamwork and the development of interpersonal skills and autonomy in learning. Mason (1998) mentions that supervisors report that learners involved in team learning have a greater ability to solve problems and assume greater responsibility for their learning.

*2.6 Reasons for a failed curriculum and poor outcomes*

All aspects presented above focus on the potential strengths of the outcomes-based curriculum. If it is generally agreed that curriculum changes should facilitate more ambitious learning goals for learners, why do we, then, read about failed curricula? A failed curriculum means learners are not achieving the outcomes they are supposed to achieve.

Rogan (2004) analysed 18 videotaped science lessons for his case study done in South Africa. In most of these lessons he found that the specified outcomes of Curriculum 2005 are not being met. In his study he describes the old curriculum as a frying pan and found that in 5 lessons out of 18 learners were jumping from one frying pan into another. He further stated that, "the intended benefits of OBE are hard to find in the science classrooms". Is this the same in mathematics? As the cause for poor outcomes, Verspoor (1989) points the finger at poor implementation, while Hiebert (1999) blames the teaching, and Battista (1999) criticises the standard of the materials.

In the USA, over the past twenty years, materials were developed to support standards-based education. However, such materials and their associated teaching methods have not all been well received by all parties (Battista, 1999).

Even though a curriculum may show great promise in research settings, schools and districts may not implement it effectively. Verspoor (1989) points out that large-scale programmes tend to emphasise adoption and neglect implementation. He, furthermore, mentions that, in nearly all instances, low outcomes result from poor implementation of what is essentially a good idea. It takes time, patience, and skill to implement the vision of OBE.

Poor implementation can result in poor teaching. The Hawaii State Performance

Standards Review Commission for Effectiveness and the Implementation of the Performance Standards (2002) mentions in its report that performance standards (learner outcomes – what learners should be able to do) could be linked directly to teaching. Hiebert (1999) puts the blame of poor learner outcomes directly on the teachers. According to him, the reason is simple, though under-appreciated – poor teaching.

The new, more ambitious, OBE curriculum in South Africa requires of teachers to make substantial methodological changes. It is difficult for teachers to change the way they teach. One does not acquire new methods automatically; one must learn them. Most teachers have relatively few opportunities to learn new methods of teaching (Hiebert, 1999). Here I want to refer to the term used by Haberman (1991) namely "pedagogy of poverty" for describing the lack of new teaching methods. Teachers need sustained, ongoing, professional development in order to offer learners high-quality mathematics education. Curriculum 2005 requires extended and sustained professional development of teachers and a large degree of administrative support. Outcomes-based education will flounder if suitable high-quality staff development and sufficient support are not available (Botha, 2002).

**2.7 Divisions in society**

In South Africa the political dispensation and complex structure of the society pose problems of its own. Is OBE going to improve the performance of all learners or only of a particular group of learners? Is it again going to create a division in South African society? Lubienski (2000) in a study done in the USA, notes that, in his own teaching, working-class learners are less confident and successful than middle-class learners. He further states that the reform-orientated approaches to mathematics may not enhance the achievement of all learners, as reformers originally hoped and claimed.

## 2.8 Conclusion

This chapter has given an overview of what research publications mention about the success of OBE mathematics teaching as well as the possible reasons for a failed OBE curriculum. It indicates how the implementation of OBE has improved the learners' understanding of mathematics in some countries. It also mentions the poor achievement in science classes in South Africa. It raises the question whether or not OBE will eliminate the past historical differences and create one society with equal opportunities for all.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter describes in detail how the research was conducted, and what methodology was used. The research follows a case study approach using both a qualitative and quantitative mode of inquiry.

## 3.2 Subject of the research

All provinces in South Africa were given the mandate by the national government to implement Curriculum 2005; Mpumalanga Province is one of them. The research was conducted in Mpumalanga Province and involved eleven schools. Most of the schools taking part in the project are situated in rural areas. All these schools have a history of lacking resources. The learners in the schools mostly come from historically disadvantaged backgrounds.

The data that were used in this study were captured by educators from the Mpumalanga Secondary Science Initiative (MSSI) Project. MSSI is a collaboration of three main stakeholders: the Japanese International Cooperation Agency (JICA), the Mpumalanga Department of Education and the Centre for Science Education at the University of Pretoria. The aim of the MSSI Project is to assist Grades 8 and 9 mathematics and Science teachers to implement Curriculum 2005. MSSI has been doing this since 2000. One of the tasks of the MSSI project staff was to collect data regarding the implementation of Curriculum 2005 in Grades 8 and 9.

Data were collected in three different ways: questionnaires completed by the mathematics and Science teachers and learners involved in the project, video-taped mathematics and science lessons conducted in Grades 8 and 9 classes, and interviews with the Grades 8 and 9 learners and teachers.

Because of the tight time frame and financial implications, I decided to use the data as collected by the MSSI staff. Another reason to use the data from MSSI data collection is that the teachers of MSSI project schools were used to the MSSI project staff, while I would have been a stranger to them. This means that when educators were teaching, they were not distracted by the MSSI project staff being present. In other words, it did not detract from the natural teaching environment.

### 3.3 Data capturing

The MSSI project staff adopted a case study approach in the way they captured the data. A case study is "an intensive holistic description and analysis of a single entity, phenomenon or social unit" (Merriam, 1988). Case studies are generally seen to be qualitative in nature. In the field of education, a case study could involve, for instance, interviews with teachers and classroom observations. Brady (1995) mentions in his study that those two methods of data collection, that is, interviews and observations, are essential in case studies. Gay (1987) claims that an interview has a number of unique advantages and disadvantages. When well conducted, interviews can produce in-depth data that cannot be obtained with questionnaires. Interviews are better than questionnaires according to Lofland's theory of analytic induction (Lofland and Lofland, 1984): "Face to face interaction is the fullest condition of participation in the mind of another human being." On the other hand, conducting interviews is expensive and time consuming.

The Faculty of Development Services of the University of Pittsburgh (in the USA) (2003) mentions in its policy that classroom observation provides an opportunity to gather data on the teaching/learning activities in a class. Classroom observation permits researchers to study the processes of education in natural settings and provides more detailed and precise evidence compared to other data sources. Many of the reviews and summaries of classroom observation research have consistently found that classroom behaviour significantly relates to learners' academic achievement. In other words, research using classroom observation has provided a substantial knowledge base that has helped to understand effective teaching.

After studying advantages and disadvantages of the interview and observation data collection methods and viewing some videotapes and listening to interview tapes, I, the researcher, decided to use these mathematics videotapes for the analysis.

The MSSI Project staff is competent in video taping the class lessons. While video taping, two MSSI team members were present (most of the time) in the classroom. This presence increases the reliability of the data. The teachers were assured that the tapes were only going to be used for research purposes and that they need not fear that these will be used against them. This eliminates observer bias because some teachers teach differently when they are video-taped.

In doing classroom observations, there are two main approaches, namely a systematic observation and an ethnographic approach (Mbano, 2002).

*Systematic observation:*

> It is a process whereby an observer or a group of observers devise a systematic set of rules for recording and classifying classroom events (Mbano, 2002, p.86).
>
> The results of such observations are normally reported in numerical or quantitative terms as percentages or averages and may form the basis for a variety of statistical analyses (Croll, 1986, p.1).

*Ethnographic approach:* Ethnography involves intensive data collection, that is, the collection of data on many variables over an extended period of time, in a naturalistic setting (Gay, 1987). To make this approach successful it requires individuals that are highly trained in observation, and they collect vast amounts of data over a long period of time.

Due to the restricted timeframe available for research and analysis, and the plan to use the videotapes taped by the MISS project staff, a purist following of the ethonographic methodology was inappropriate. For this reason, I decided to use the systematic observation approach in viewing and interpreting the data on the videotapes.

Although there are several types of observational procedures or techniques that have been used to examine effective teaching, the most widely used procedure or research method has been systematic classroom observation based on interactive coding systems. These interactive coding systems allow the observer to record nearly everything that learners and teachers do during a given time interval.

Based on this choice, an observation instrument was developed to guide me while viewing the videotapes. The observation instrument consisted of a checklist that directed my attention to particular items during the viewing (see Appendix A). Viewing the tapes allowed me to note (a) whether and when the learners achieve specific outcomes and (b) what kinds of teaching strategies were used to achieve such learning outcomes.

The advantage of video recordings is that they can be replayed as often as is deemed necessary, and this allowed me to make amendments to the observation system during this period of analysis. In fact, the actual development of the observation instrument could well be a source for other researchers to be used in the future.

### 3.4 Design for data analysis

At the onset of this research project, I knew in very broad terms that I wished to combine the use of quantitative and qualitative approaches, and I wished to explore the practice of combining such approaches.

According to Page and Meyer (2000), a qualitative approach can be conceptualised as having a focus on the quality of an event or experience. In this paradigm the researcher intended to focus on classroom teaching of mathematics as such an event. According to the same authors, a quantitative approach places greater value upon information that can be numerically manipulated in a meaningful way.

Fraser (1998) mentions that educational researchers claim that there is merit in moving beyond thinking in terms of a dichotomy and thus simply choosing between quantitative or qualitative methods. Depending on the context and the research question, one should be at liberty to combine both methods. Page et al. (2000: p.17) support the idea of using both approaches by saying "It is usually possible and desirable to include both approaches". Cohen, Manion and Morrison (2003: p.45) agree, quoting from Merton and Kendall

> "Social scientists have come to abandon the spurious choice between qualitative and quantitative data: they are concerned rather with that combination of both which makes use of the most valuable features of each. There are times when one approach will have an advantage over the other or will give information the other cannot. The problem becomes one of determining at which point they should adopt the one approach, and at which point the other approach."

In this study I decided to adopt the quantitative component to support the qualitative component.

### 3.5 Procedure

I explain in this section how the data were analysed and how I explored the data is explained in this section. For this study, the video recordings of eleven mathematics lessons were selected from eleven different schools. All these lessons were video-taped during May to June, 2002. Findings are based on the analysis of video-taped lessons. Conclusions were then drawn based on the analysis. These conclusions cannot be generalised, however, since only eleven lessons were chosen for the study. The findings are merely an indication of what is likely to happen in other lessons with regard to teacher input and how learning outcomes are likely to be addressed.

Each video taped lesson was digitally labelled as lesson 1 to lesson 11. Teachers' names were coded using alphabetical letters from A to K to keep their privacy. Out of the eleven lessons, four were taught by female educators and the remaining seven were taught by male educators (see Table 3.1). My approach was unbiased with regard to gender. In the videotapes I found that the teachers treated male and female learners equally. It is difficult to find the number of learners in each lesson but all classes were approximately full of learners. From the tapes it is difficult to determine the number of male and female learners in each lesson but female learners were visible in each lesson. Six of the lessons were on Grade 8 level and five on Grade 9 level.

| **Videotapes** | **Gender of the facilitator** | **Topic** | **Grade** |
|---|---|---|---|
| Lesson 1 | Female | Algebra | 9 |
| Lesson 2 | Male | Algebra | 8 |
| Lesson 3 | Male | Geometry | 8 |
| Lesson 4 | Male | Algebra | 9 |
| Lesson 5 | Male | Algebra | 8 |
| Lesson 6 | Male | Algebra | 9 |
| Lesson 7 | Male | Algebra | 8 |
| Lesson 8 | Female | Geometry | 8 |
| Lesson 9 | Male | Algebra | 8 |
| Lesson 10 | Female | Algebra | 9 |
| Lesson 11 | Female | Algebra | 9 |

Table 3.1: Distribution of mathematics video lessons.

Because many of the schools in South Africa neglect geometry topics, I paid particular attention to the two videotaped geometry lessons.

Each video recording tape was viewed at least twice. For the first viewing, the aim was to observe the different types of segments occurring naturally in the lesson, and to make qualitative notes. For the second viewing the observation instrument was used in order to record the observations.

Sheet 1 of the observation instrument (Appendix A) is divided into four main columns:

1. The time that is spent on the different type of segment (activities)
2. The educator's actions during that time
3. The learners' actions during that time
4. The specific outcomes intended and achieved as a result of educator's input.

Rogan (2004) mentions that outcomes cannot be demonstrated in a vacuum. Before demonstrating an outcome, learners will need to acquire certain skills, knowledge and/or attitudes. Therefore, Column 4 for *the specific outcomes* is subdivided into i) input and ii) outcome. Input is recorded as the teacher's contribution needed so that the learner will achieve and demonstrate the outcome. Output is recorded as whether any specific outcomes were being attempted by the learners, regardless of quality as Rogan (2004) did it in case study. Another reason for subdividing *specific outcomes* in Column 4, was that the teachers contribution (an input) laid a foundation for later realisation of an outcome by the learners.

The second and third columns were filled by ongoing record keeping and changes whenever the activity changes. In Column 4 the frequency of occurrence of specific outcomes was recorded.

Sheet 2 of the observation instrument (Appendix B) was designed based on Sheet 1. It has three main columns: i) for each specific outcome, ii) for the educator and iii) for the learners. The educator's column is subdivided in two sections: a) input time for a specific outcome and b) the teaching method used to demonstrate that specific outcome. The learners' column is also divided in two: a) to verify whether the particular outcome was achieved during that period and b) to enter the time the learners needed to achieve this specific outcome.

Integrating Sheets 1 and 2 of the observation instrument, I prepared Table 1 (Appendix C) for each specific outcome. This table has eight columns for each of the eleven lessons.

Based on Table 1 the summary table (Appendix D) was drawn up. It contains seven columns and ten rows, one for each specific outcome, another for time spent on things other than outcomes and another row for the total; altogether twelve rows.

In this manner the observation instrument was used as the guideline to view the tapes, and to record and analyse the observations.

### 3.6 Conclusion

In this chapter, I outlined the research design and methodology that was followed in the study. I, furthermore, presented the reasons why particular methods were followed. I also explained the geographical and educational area where the research data were collected, how it was collected, and why I decided to make use of it. The last part of the chapter explains the development of the observation instrument, and the procedures of observing and analysing the data.

# CHAPTER FOUR

# BREAKDOWN OF LESSONS WITH RESPECT TO LEARNING OUTCOMES AND TIME ALLOCATION

## 4.1 Introduction

In the previous chapter the research methodology used in the study was explained. The different aspects of the procedures for observation and analysis were mentioned. In this chapter the information gathered through these procedures is quantitatively analysed in detail to find out how time was spent in attempting to achieve specific outcomes. I also report on how the teacher's input time, which is the time spent by the teachers to lay the foundation for the later realisation of outcomes, correlated with the outcome time, which is the time spent by the learners attempting to achieve the outcomes.

## 4.2 Results based on the lessons observed

In this section I list the results of the eleven observed lessons.

### 4.2.1 Lesson No 1

A female teacher was teaching Grade 9 learners. She used a group work method to teach the topic of ***addition and subtraction of fractions***. Learners attempted to achieve two outcomes, SO1 and SO9. Total time of this lesson was 60 minutes. The standard of the content was very basic for Grade 9 learners.

**Breakdown of the observation of Lesson 1**

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 7 min | Arranges the class into six groups. Distributes a work sheet. Mentions and writes the topic: *Addition and subtraction of fractions.* | Move from one place to another place in the classroom. | **SO9** Facilitate the sharing of observations using all forms of verbal communication. | |
| 5 min | Gives one question dealing with *addition* (3/4 + 5/6) (problem 1) to learners to solve individually. Explains to one group. Questions and answers to one group. | Start solving problem 1. One group listens and answers questions from the teacher. | (Basic)**SO1** Facilitate the understanding of rational numbers. | |
| 5 min | Explains to the whole class how to calculate ½ + ¼ as an example. Explains to find the L.C.M of 4 and 6 then gives guidance to solve (3/4 + 5/6). Questions and answers. | Listen and answer the questions from the teacher. | **SO1** Facilitate the understanding of rational numbers. | |
| 7 min | Writes down problem 2 on the chalkboard. (2/5 + 6/7) Allows learners to work in pairs to finish the problem 1. Moves around and helps learners in groups. Allows learners to work with four in a group. | Try to solve problem 1 and problem 2. | | **SO1** Illustrate knowledge of rational numbers. **SO9** Share observation s using all available forms of verbal communic- ation . |
| 3 min | Assists one learner at the chalkboard. Writes another five problems on the board. | One male learner solves problem 1 on the board. Other learners listen. Another male learner explains how to change an improper fraction $\frac{19}{12}$ to a mixed number $1\frac{7}{12}$. | | **SO1** Illustrate properties of rational numbers. |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 11 min | Asks the learners to solve problem 2: (2/5 + 6/7). Moves around and helps learners in groups. | Try to solve problem 2 in groups. | | **SO1** Illustrate knowledge of rational numbers. **SO9** Share observations using all available forms of verbal communication |
| 3 min | Explains to the class how to find the L.C.M of 5 and 7. Questions and answers. | Listen and answer. | **SO1** Facilitate understanding of rational numbers. | |
| 3 min | Moves around and assists learners in a group. Explains the steps written by the learner on the board. Questions and answers. | One male learner finishes problem 2 on the board. Some learners help learner at the board while others try to solve problem 3. | | **SO1** Illustrate knowledge of rational numbers. |
| 4 min | Moves around and assists learners. Explains the steps written by the male learner on the board. Questions and answers. | One female learner tries to do the problem 3 on the board, but does not manage. Another male learner tries to do problem 3. Others listen and some just talk. | | **SO1** Illustrate knowledge of rational numbers. |
| 9 min | Writes down two more problems (problem 7 and problem 8). Moves around and assist learners. Marks and corrects learners work. Mentions that subtraction is similar to addition. | Try to solve problem 7 as a group. Listen. | | **SO1** Illustrate knowledge of rational numbers. **SO9** Share observations using all available forms of verbal communication. |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 3 min | Explains problem 7:<br>(7/8 + 2/3) on the board.<br>Questions and answers.<br>Problem 5, problem 6 and problem 8 are set as homework. | Listen and answers. | **SO1**<br>Facilitate the understanding of rational numbers. | |

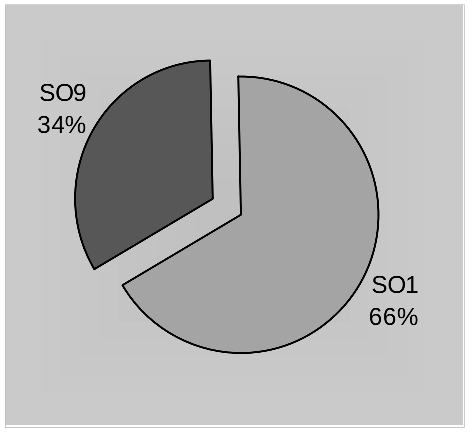



**Figure 4.2.1 Time spent on SO's in L 1**

### 4.2.2 Lesson No 2

A male teacher was teaching Grade 8 learners for the period of 50 minutes. He used the discussion method to teach the topic of ***zero as an exponent***. Learners attempted to achieve two specific outcomes: SO1 and SO9.

**Breakdown of the observation of Lesson 2**

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Output |
| 5 min | Explains what exponents are, using<br>$3^2 =$<br>$p^5 \div p^5 =$<br>$p^5 \div p^2 =$<br>Questions and answers. | Listen and answer. | **SO1**<br>Facilitate the understanding of the use of powers to represent repeated multiplication to show understanding of exponents. | |

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 1 min | Gives $a^5 \div a^2 =$ to solve. Gives instructions to guide learners. Moves around and assists learners. | Try the problem. | | **SO1** Demonstrate the use of powers to represent repeated multiplication to show understanding of exponents. **SO9** Apply the laws that apply to integer exponents. |
| 1 min | Listens to learner at the board. | One male learner at the board, others listen. | | **SO1** Demonstrate the use of powers to represent repeated multiplication to show understanding of exponents. **SO9** Apply the laws that apply to integer exponents. |
| 2 min | Asks learners to find a different method to solve the same problem. Moves around and assists learners. | Learners try a different method. | | **SO1** Demonstrate the skills of investigative approaches within mathematics. |
| 2 min | Listens to the learner. Explains learner's work to other learners. | One male learner at the board, others listen. | | **SO9** Apply the laws that apply to integer exponents. Share observations using all available forms of verbal communication. |
| 5 min | Explains zero as an exponent using $2^3 \div 2^3 =$ Questions and answers. | Listen to the teacher. Questions and answers. | **SO9** Facilitate formulation and application of laws that apply to integer exponents. | |

| **Time (min)** | **Teacher's action** | **Learners' Action** | **Specific Outcomes** | |
|---|---|---|---|---|
| | | | **Input** | **Outcome** |
| 7 min | Gives five problems to solve as a group.<br>Simplify:<br>(a) $x^3 \div x^3 =$<br>(b) $m \div m =$<br>(c) $\frac{p^7}{p^7} =$<br>(d) $p^{10} \div p^{10} =$<br>(e) $12.x^0 =$<br><br>Moves around and assists. | Discuss and try problems. | | **SO9**<br>Formulate and apply the laws that apply to integer exponents.<br><br>Share observations using all available forms of verbal communication. |
| 13 min | Listens to the learner at the board. Explains learner's work to the whole class.<br>Questions and answers. | The leader of each group reports on one question at the chalkboard and answers questions posed by learners.<br>Other learners listen and correct mistakes. | | **SO9**<br>Formulate and apply the laws that apply to integer exponents.<br>Share observations using all available forms of verbal communication. |
| 11 min | Gives four more problems for the groups to do.<br>If $x = 2$ and $y = 3$, find the value of:<br>(a) $x^0 . 2^0 =$<br>(b) $p^2 \div p^2 =$<br>(c) $(xy)^0 =$<br>(d) $\frac{p^{xy} . p^3}{p^7 . p^2} =$<br>Moves around and assists learners as a group. | Discuss and try the problems. | | **SO9**<br>Apply the laws that apply to integer exponents.<br><br>Share observations using all available forms of verbal communication. |

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 3 min | Explains problem (d) on the board to the whole class. Questions and answers. | Listen and answer questions. | **SO9** Facilitate the understanding of the ability to apply the laws that apply to integer exponents. | |

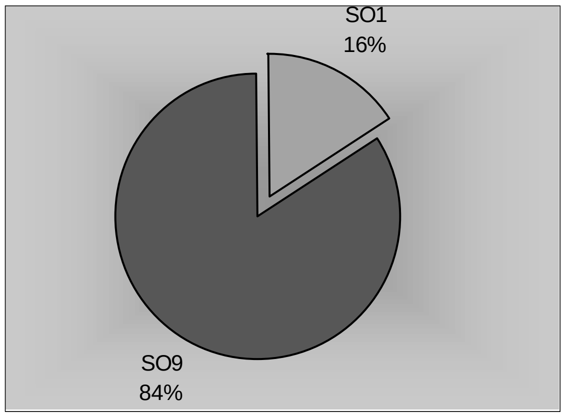



**Figure 4.2.2 Time spent on SO's in L 2**

### 4.2.3 Lesson No 3

A male teacher used the group work method to teach the topic of ***parallel lines*** to Grade 8 learners for a period of 48 minutes. It is a geometry topic. Learners attempted to achieve two specific outcomes, SO5 and SO9.

### Breakdown of the observation of Lesson 3

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 11 min | Draws two parallel lines and a transversal line. Names them as *AT* and *BX*. Names the angles. Explains parallel lines. Questions and answers. Gives instruction to draw the lines. | Listen and answer. Draw parallel lines and transversal on the paper. Name them. | **SO5** Facilitate creativity and design by using scale drawings and measurement. | **SO5** Create and design using scale drawings and measurement. |

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 8 min | Mentions corresponding angles are equal. Finds corresponding angles using *F* shape. Explains how to find corresponding angles. Questions and answers. | Listen and answer. | **SO5** Facilitate the understanding of relationships between angle measurement and properties of parallel lines. | |
| 2 min | Mentions that alternate angles are equal. Finds alternate angles using *Z* shape. Explains how to find alternate angles. Questions and answers. | Listen and answer. | **SO5** Facilitate the understanding of relationships between angle measurement and properties of parallel lines. | |
| 4 min | Mentions that co-interior angles are supplementary. Finds co-interior angles using *C* or *U* shapes. Explains how to find co-interior angles. Questions and answers. | Listen and answer. | **SO5** Facilitate the understanding of relationships between angle measurement and properties of parallel lines. | |
| 8 min | Gives activity 1: Find the corresponding, alternate and co-interior angles in figure. Ask learners to find the corresponding angles in figure. Moves around class and check individual learners' work. | Do activity 1. | | **SO5** Understanding the relationships between angle measurement and properties of parallel lines. |
| 5 min | Asks one learner to write corresponding angles on the board. Questions and answers. Assists and explains. Asks learners to mark their work. | One male learner does activity 1 on the chalkboard. Other learners assist. Listen and answer. Mark the answers. | **SO5** Facilitate the understanding of relationships between angle measurement and properties of parallel lines. | **SO9** Share knowledge using all available forms of verbal communication. |

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 3 min | Asks one learner to write alternate angles on the board. Questions and answers. Assists and explains. Ask learners to mark their work. | One female learner does activity 1 on the chalkboard. Other learners assist. Listen and answer. Mark the answer. | **SO5** Facilitate the understanding of relationships between angle measurement and properties of parallel lines. | **SO9** Share knowledge using all available forms of verbal communication. |
| 5 min | Asks one learner to write co-interior angles on the board. Questions and answers. Assist and explain. Ask learners to mark their work. | One male learner does activity on the board. Other learners assist him. Listen and answer. Mark the answer. | **SO5** Facilitate the understanding of relationships between angle measurement and properties of parallel lines. | **SO9** Share knowledge using all available forms of verbal communication. |
| 2 min | Summarises the work. Questions and answers. | Listen and answer. | **SO5** Facilitate the understanding of relationships between angle measurement and properties of parallel lines. | |

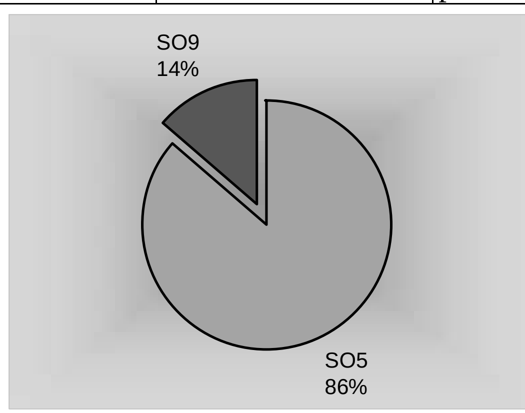



**Figure 4.2.3 Time spent on SO's in L 3**

### 4.2.4 Lesson No 4

A male teacher was teaching to Grade 9 learners the topic of ***algebraic fractions*** and he used a group work method to do this. Duration of the period was 49 minutes. The learners attempted to achieve three specific outcomes, SO1, SO9 and SO10.

**Breakdown of the observation of Lesson 4**

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 4 min | Explains how to simplify $\frac{ab+a}{ab}$ Gives 1. $\frac{7a+14}{7a}$ to simplify. Questions and answers. | Listen and answer. | **SO1** Facilitate the understanding of algebraic techniques. | |
| 7 min | Moves around and assists learners in a group. | Try the problem as a group. Get assistance. | | **SO1** Illustrate algebraic techniques. **SO9** Share knowledge using all available forms of verbal communication. |
| 3 min | Asks one learner to do the problem on the board. Explains the learner's work to other learners. Questions and answers | One female learner does the problem on the board. Others listen. Questions and answers. | **SO1** Facilitate the understanding of algebraic techniques. | **SO1** Illustrate algebraic techniques. **SO9** Share knowledge using all available forms of verbal communication. |
| 9 min | Gives another two problems to simplify. 2. $\frac{5a^2+a^2}{5a}$ 3. $\frac{2x^2+2x}{2x}$ Moves around and assists learners in a group. | Try the problem as a group. Get assistance. | | **SO1** Illustrate algebraic techniques. **SO9** Share knowledge using all available forms of verbal communication. |

| Time (min) | Teacher's action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 17 min | Asks one group leader to do the problem 2 on the board. Problem 3 has two different answers from different groups. Two different learners asked to solve it on the board: One group got $\frac{x^2+x}{x}$, another group got $x + 1$. Whole class is allowed to argue the answers. Explains which is correct and why. Questions and answers. | One female learner solves problem 2 on the board. Others listen. One male and one female learner solve the problem on the board. All learners debate the answers. Questions and answers. | | **SO1** Illustrate algebraic techniques. **SO9** Share knowledge using all available forms of verbal communication. **SO10** Explain the strategies followed in their problem solving process. |
| 9 min | Writes down two more problems. 4. $\frac{3a^2b-6ab}{6ab}$ 5. $\frac{p^2-4p}{p^2-4}$ Asks the learners to try. Asks one learner to do problem 4 at the board. Explains learner's work to the class. Questions and answers. Explains problem 5 to the whole class. Questions and answers. | Try problem 4. One female learner does problem 4 on the board. Listen and answer. | **SO1** Facilitate understanding of algebraic techniques. | **SO1** Illustrate algebraic techniques. **SO9** Share knowledge using all available forms of verbal communication. |

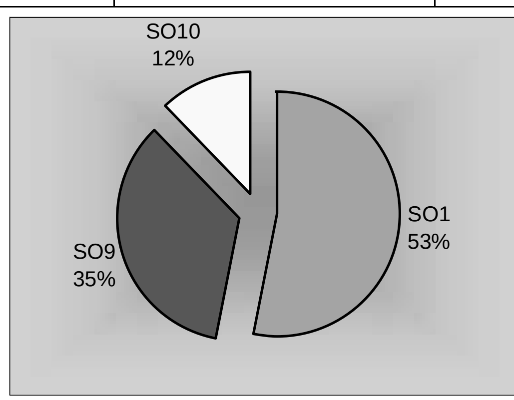



**Figure 4.2.4 Time spent on SO's in L 4**

### 4.2.5 Lesson No 5

A male teacher was teaching to Grade 8 learners for a period of 45 minutes. He used a lecturing method to teach the topic of ***factorisation***. Learners attempted to achieve two specific outcomes, SO2 and SO9.

**Breakdown of observation of Lesson 5**

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 5 min | Asks one learner to do home work Q1: Factorise $2(x + 1) + 3(x + 1)$ on the board. Explains learner's work. | One female learner does Q1 on the board. Others listen. Some talk. | | **SO2** Derive processes for general rule. **SO9** Simplify expressions into a format more suited to analysis. |
| 3min | Asks one learner to do homework Q2: Factorise $p(x + y) – 2(x + y)$on the board. Explains learner's work. | One female learner does Q2 on the board. Others listen. Some talk. | **SO2** Facilitate the processes to derive the general rule. **SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | **SO2** Derive processes for general rule. **SO9** Simplify expressions into a format more suited to analysis. |
| 5min | Asks one learner to do homework Q3: Factorise $(p + x) – m(p + x)$ on the board. Asks another learner to correct the mistake. Explain the learner's work. | One female learner does Q3 on the board. Others listen. Another female learner makes the correction. Some talk. | | **SO2** Derive processes for general rule. **SO9** Simplify expressions into a format more suited to analysis. |
| 5 min | Asks one learner to do homework Q4: Factorise $ab(q – r) – cd(q –r)$ on the board. Explains the learner's work. | One male learner does Q4 on the board. Few listen. Others talk. | **SO2** Facilitate the processes to derive the general rule. **SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | **SO2** Derive processes for general rule. **SO9** Simplify expressions into a format more suited to analysis. |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 3min | Asks one learner to do home work Q5: Factorise (½ $x$ –1) + $p$ (½$x$ –1) on the board. Explains learner's work. | One female learner does Q5 on the board. Others listen. | **SO2** Facilitate the processes to derive the general rule. **SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | **SO2** Derive processes for general rule. **SO9** Simplify expressions into a format more suited to analysis. |
| 2 min | Summarises the work. Ask the learners to do the corrections. | Listen. Do corrections. | **SO2** Facilitate the processes to derive the general rule. **SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | |
| 7 min | Explains the factorisation of: $a(x – y) + x – y$ Questions and answers | Listen and answer | **SO2** Facilitate the processes to derive the general rule. **SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | |
| 7 min | Explain the factorisation of: $ax – 2a + 3(x – 2)$ Questions and answers | Listen and answer | **SO2** Facilitate the processes to derive the general rule. **SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | |
| 6 min | Explains the factorisation of: $2a + 2b + 8a + 8b$ Questions and answers | Listen and answer | **SO2** Facilitate the processes to derive the general rule. **SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 2min | Gives class activity to learners on the board. It has four questions.<br>Factorise:<br>1. $ma + mb + x(a + b)$<br>2. $x - x^2 - (1 - x)$<br>3. $pb - pt + 3b - 3t$<br>4. $3p + pm + 3 + 3m$ | Copy the activity. | **SO2**<br>Facilitate the processes to derive the general rule.<br>**SO9**<br>Facilitate ability to simplify expressions into a format more suited to analysis. | |

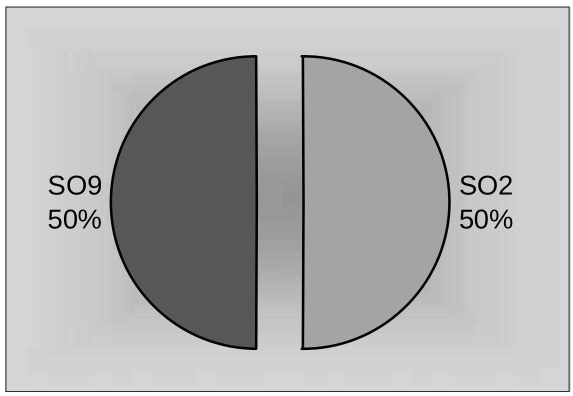



Figure 4.2.5 Time spent on SO's in L 5

### 4.2.6 Lesson No 6

A male teacher used the facilitating method to teach the topic of ***linear graphs*** to Grade 9 learners for a period of 45 minutes. Learners attempted to achieve three specific outcomes, SO2, SO7 and SO9.

**Breakdown of the observation of Lesson 6**

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes: Input | Specific Outcomes: Outcome |
|---|---|---|---|---|
| 13 min | Does the correction of the homework (HW) question 1. Checks whether the following points lie on the graph: $y = -2x + 3$ (a) (-4, 7) (b) (0, 3) (c) (-1,1) (d) (1,1) Explains (a) to the learners. Ask one learner to do (b) on the board. Explains learner's work. Asks one learner to do (c) on the board. Explains learner's work. Explains (d). Questions and answers. Asks the learners to correct the homework. Goes around and marks the homework and corrections. | One male learner does the homework (b) on the board. One male learner does the homework (c) on the board. Listen and answer. Correct the homework. | **SO2** Facilitate ability to generate linear patterns. **SO7** Facilitate ability to display knowledge of the development of the coordinate system. Facilitate ability to locate position within a two dimensional space. | **SO2** Generate linear patterns. **SO7** Display knowledge of the developme nt of the coordinate system. Locate position within a two dimension al space. |
| 9 min | Starts to investigate the graph further. Mentions the common form $y = m x + c$. Explains how to find m and c from $y = -2x + 4$. Questions and answers. Explains how to mark the intercept on the x-y axis. Asks one Learner to draw a rough sketch for $y = -2x + 4$. Corrects learner's mistake by explaining positive and negative slope graphs. | Listen. Questions and answers One male learner draws the rough sketch with positive slope. | **SO2** Facilitate ability to generate geometric patterns in two dimensions (2D). | |
| 6 min | Explains how to find slope of the equations of the graph passing through four points (0 , 1); (1 , 3); (2 , 5); (3 , 7). Explains using first two points. Questions and answers. | Listen and answer. | **SO2** Facilitate ability to generate geometric patterns in 2D. Interpret graphic representations of data involving two variables. | |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 5 min | Asks the learners to calculate the slope of the graph using the last two coordinates. Goes around and assists. | Try to find the slope of the graph. | | **SO2**<br>Generate geometric patterns in 2D. Interpret graphic representations of data involving two variables. |
| 4 min | Explains how to find the *y*-intercept in the equation $y = 2x + c$ using (2 , 5). Questions and answers. | Listen and answer. | **SO2**<br>Facilitate ability to generate geometric patterns in 2D.<br>**SO9**<br>Facilitate ability to interpret graphic representations of data involving two variables. | |
| 4 min | Asks the learners to substitute points 1 and 4 to find whether they are in the graph. Moves around and assists. | Try to substitute. | | **SO2**<br>Generate geometric patterns in 2D. |
| 4 min | Asks the learners to find the equation of the graph passing through the following three points. (0 , -2); (1 , 1) ; ( 2 , 4). Moves around and assists Learners. | Try the problem as a group. | | **SO2**<br>Generate geometric patterns in 2D. |

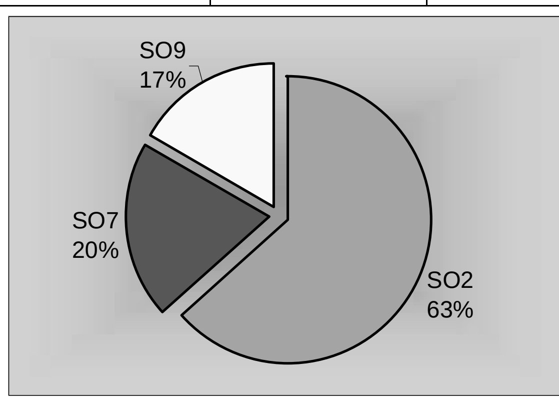



**Figure 4.2.6 Time spent on SO's in L 6**

### 4.2.7 Lesson No 7

A male teacher was facilitating the topic of ***BODMAS*** using the discussion method to Grade 8 learners. Learners attempted to achieve two specific outcomes: SO1 and SO9. The lesson duration time was 60 minutes.

**Breakdown of the observation of Lesson 7**

| **Time (min)** | **Teacher's Action** | **Learners' Action** | **Specific Outcomes** | |
|---|---|---|---|---|
| | | | **Input** | **Outcome** |
| 8 min | Explains what BODMAS is.<br>Questions and answers.<br><br>Explains the order to solve<br><br>$\frac{1}{2} + (\frac{3}{5} \text{ of } \frac{2}{8}) \div \frac{4}{6} - \frac{3}{4} \text{ of } 3$ | Listen and answer. | **SO1**<br>Facilitate the understanding of rules of order of operations.<br>Facilitate ability to perform complex calculations using BODMAS. | |
| 23 min | Distributes worksheet.<br>Asks the class to do the work sheet as a group for presentation. Goes around and assists the learners in groups. | Discuss and try to do the problems. | | **SO1**<br>Illustrate the rules of order of operations.<br>**SO9**<br>Share observations using all available forms of verbal communication. |
| 5 min | Writes worksheet problems 1(b) - (d) on the board. Asks one group leader to do 1(b) on the board. | One male learner does problem 1(b) on the board with the help of his group. Others listen. | | **SO1**<br>Illustrate the rules of order of operations.<br>**SO9**<br>Share observations using all available forms of verbal communication. |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 5 min | Asks another group leader to do 1( c) on the board.<br>She wants to take her answer paper to the board. The class does not grant her permission. | One female learner does problem 1(b) on the board with the help of her group. Others listen and find the mistake and point it out. | | **SO1**<br>Illustrate the rules of order of operations.<br>**SO9**<br>Share observations using all available forms of verbal communication. |
| 3 min | Asks another group learner to correct the mistake.<br>Explains the mistake.<br>Explains ***of*** again. | One female learner does the correction on the board.<br>Others listen. | | **SO1**<br>Illustrate the rules of order of operations.<br>**SO9**<br>Share observations using all available forms of verbal communication. |
| 5 min | Explains 1(d) to the class.<br>$\frac{2}{3}\ of\ (\frac{5}{8} \times \frac{4}{15}) \div \frac{4}{6}$<br>Questions and answers. | Listen and answer. | **SO1**<br>Facilitate under-standing to illustrate the rules of order of operations | |
| 1 min | Summarises the worksheet. | Listen. | **SO1**<br>Facilitate the ability to illustrate the rules of order of operations | |
| 10 min | Gives two problems (one simple and one complex) to simplify as an individual. Gives instructions. Marks the work sheets. Goes around and checks the learners' work. Collects the work for marking. | Try the problems. | | **SO1**<br>Illustrate the rules of order of operations. |

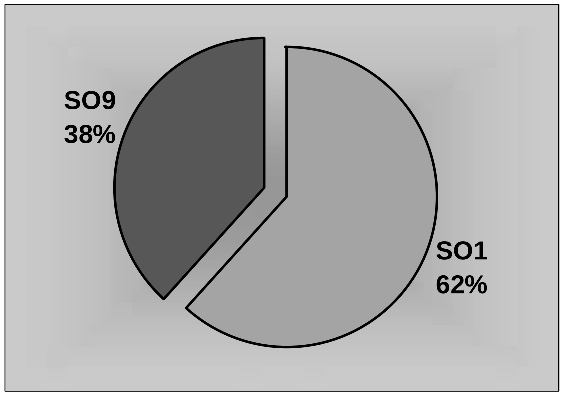
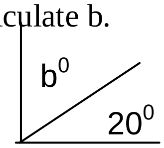


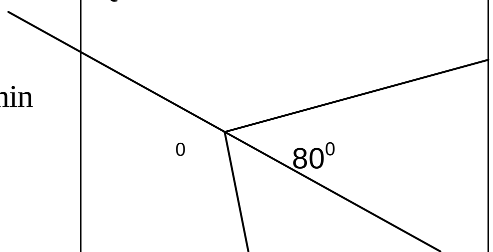
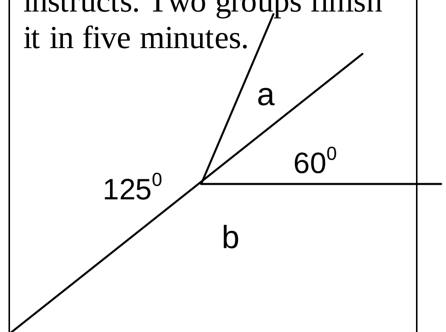

**Figure 4.2.7 Time spent on SO's in L 7**

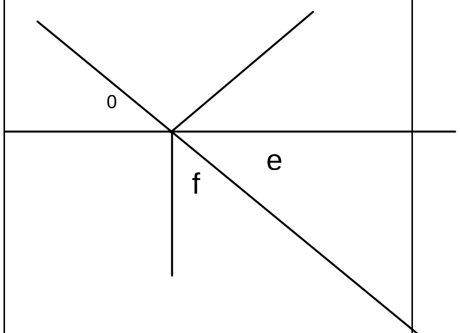
### 4.2.8 Lesson No 8

A female teacher taught Grade 8 learners. She demonstrated the topic of ***angles around a point***. This is a geometry topic. Learners attempted to achieve two specific outcomes, SO5 and SO10. The lesson duration time was 45 minutes.

**Breakdown of the observation of Lesson 8**

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 4 min | Explains what is a right angle. Explains the use of a protractor. Questions and answers. | Listen and answer. | *SO5*<br>Facilitate applying formulae used in measurements and creativity by using scale drawings. | |
| 3 min | Explains how to calculate an angle without measuring it:<br>Calculate b.   | Listen and answer. | *SO5*<br>Facilitate applying formulae used in measurements. | |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 2 min | Explain angle at a point. Explain at a point. Questions and answers. | Listen and answer. | *SO5*<br>Facilitate applying formulae used in measurements. | |
| 8 min | Explains how to calculate c and d from the diagram. Questions and answers.<br><br> | Listen and answer. | *SO5*<br>Facilitate applying formulae used in measurements.<br>**SO10**<br>Facilitate the use of various problem-solving strategies. | |
| 7 min | Gives one problem (Q1) to solve: Calculate *a* and *b* in the diagram. Goes round and instructs. Two groups finish it in five minutes.<br><br> | Try the problem. | | *SO5*<br>Apply formulae used in measurements.<br>**SO10**<br>Use various problem-solving strategies. |
| 7 min | Explains the above question (Q1) to the whole class. Questions and answers. | Listen and answer. | *SO5*<br>Facilitate applying formulae used in measurements.<br>**SO10**<br>Facilitate the use of various problem-solving strategies. | |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 14 min | Gives another question (Q2) to solve.<br>Q2: Find $e$ and $f$ in the diagram. Goes around and watches.<br><br> | Try to solve the problem. | | *SO5*<br>Apply formulae used in measurements.<br>**SO10**<br>Use various problem-solving strategies |

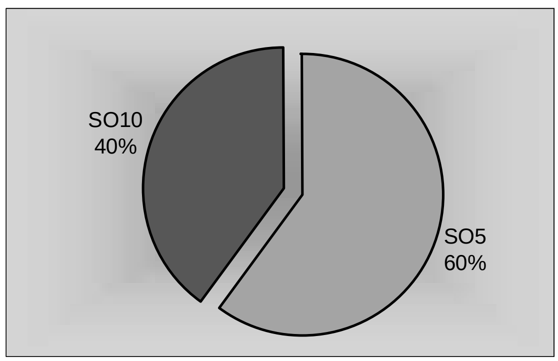



**Figure 4.2.8 Time spent on SO's in L 7**

### 4.2.9 Lesson No 9

A male teacher was teaching to Grade 8 learners. The topic is ***words problems in fractions***. He used the discussion method using case studies to explain the topic. The teacher started the lesson with the case study. In the end the teacher went back to the traditional way of teaching. Learners attempted to achieve two specific outcomes: SO1 and SO9. The standard of the topic was very low for Grade 8. The lesson duration was 45 minutes.

**Breakdown of the observation of Lesson 9**

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 6 min | Distributes work sheets to the groups, three for each group. Questions and answers. Reads case study 1 to the class. Questions and answers. Asks learners to read the case study again and to analyse, then to draw a diagram and answer questions (a) and (b). Case study: Catherine and Tom have a square cake. They give half of the cake to Grandpa. They shared the remaining half equally among them. (a) What fraction of the whole cake does each of them get? Grandpa shared with Thabo. He said to Thabo: Because I am older I get two thirds of this half. (b) What fraction of the whole cake does Grandpa eat? | (Note: The learners are already in groups.) Listen and answer. | **SO9** Facilitate the simplify-cation of expressions and equations into format more suited to analysis. Facilitate the use of models and solve problem situations by setting up suitable equations. | |
| 3 min | Goes around and assists learners. | Read, analyse and discuss the case study. | | **SO9** Share observations using all available forms of verbal communication. |
| 11 min | Draws a square diagram on the board. Explains the case study using the diagram with the help of learners. Questions and answers. | Listen and answer. Some learners copy the diagram for explaining on the board. One female learner explains how Tom got one quarter of the cake. | **SO9** Facilitate the use of models and solve problems by using of diagrams. | **SO9** Model and solve problems by using of diagrams. |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 6 min | Explains what an octagon is. Asks learners to colour half of the octagon. Asks learners to mark one quarter of the coloured part. Asks what fraction of the whole octagon the marked part is. Checks and corrects the learners' work. | Colour the diagram according to the instruction. Discuss and find the answer. Answer the question. | **SO9** Facilitate the use of models and solve problems by using of diagrams. | **SO9** Model and solve problems by using of diagrams. |
| 8 min | Asks the learners to draw the diagram on the board. Explains learners' work. | One female learner draws the first part. Another male learner draws the second part. It is wrong. Another female learner corrects it. | **SO9** Facilitate the use of models and solve problems by using of diagrams. | **SO9** Model and solve problems by using of diagrams. |
| 6 min | Summarises by completing the table. $\frac{1}{2}$ *of* $\frac{1}{2} = \frac{1}{4}$ $\frac{2}{3}$ *of* $\frac{1}{2} = \frac{2}{6}$ $\frac{1}{4}$ *of* $\frac{1}{2} = \frac{1}{8}$ Explain ***of*** changes to multiplication. | Listen and answer. | **SO1** Facilitate ability to calculate efficiently. Facilitate the understanding to illustrate knowledge of rational numbers. | **SO1** Calculate efficiently. Illustrate knowledge of rational numbers. |
| 1 min | Asks the class to multiply half by half. Goes around and asks questions. | Try multiplying half by half. | | **SO1** Calculate efficiently. Illustrate knowledge of rational numbers. |
| 3 min | Explains to the class multiplication. Questions and answers. | Listen and answer. | **SO1** Facilitate ability to calculate efficiently and to illustrate knowledge of rational numbers. | |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 1min | Gives 2 multiplication problems for the Learners to try. Goes around and checks. | Try the problems. | | **SO1** Calculate efficiently. Illustrate knowledge of rational numbers. |

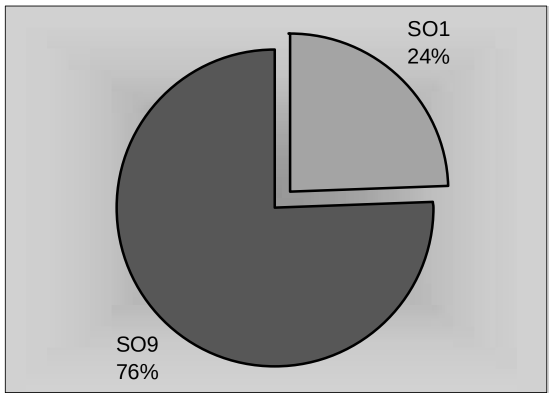



**Figure 4.2.9 Time spent on SO's in L 8**

### 4.2.10 Lesson No 10

A female teacher taught Grade 9 learners the topic of ***solving equations***. She used the lecture method to teach this lesson of 35 minutes. Learners attempted to achieve two specific outcomes: SO2 and SO9.

**Breakdown of observation of Lesson 10**

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 4 min | Writes the remedial work problems on the board.<br>Factorise:<br>1. $x^2 - 25$<br>2. $9m^2 - n^2$<br>3. $25 - 4t^2$<br>4. $169m^2 - 4$<br>5. $t^2 - 100$<br>6. $64p^2 - 9$<br>7. $144 - 9x^2$<br>Asks the learners to do the problems on the board. | Seven learners do the problems.<br>Some learners look at the board while others do something else, such as talking. | | **SO2**<br>Derive processes for general rule.<br>**SO9**<br>Simplify expressions into a format more suited to analysis. |
| 10 min | Explains what is *equal*.<br>Explains in an equation left hand side is equal to right hand side.<br>Explains how to find the value of $x$ in:<br>$x + 1 = 4$<br>Questions and answers. | Listen and answer. | **SO9**<br>Facilitate ability to simplify equations into formats more suited to analysis. | |
| 5 min | Explains how to find the value of p in:<br>$2p - 2 = 6$ with the help of learners.<br>Questions and answers. | Listen and answer. | **SO9**<br>Facilitate ability to simplify equations into formats more suited to analysis. | |
| 9 min | Explains how to solve:<br>$\frac{x}{3} - 7 = 14$<br>Questions and answers. | | **SO9**<br>Facilitate ability to simplify equations into formats more suited to analysis. | |
| 6 min | Writes one problem on the board.<br>$2x - 19 = 21$<br>Asks one learner to do it on the board. Gives guidance to the learner.<br>Asks another learner to complete the work. | One female learner does the problem on the board. Others look at the board. She leaves with $2x = 2$.<br>Another male learner completes the work.<br>Others look at the board. | | **SO9**<br>Simplify equations into formats more suited to analysis. |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 1 min | Gives a class activity to solve:<br>Pg 181: No: 6.1 and 6.2<br>Goes around and assists the learners. | Discuss the problems.<br>Try to solve the problems. | | **SO9**<br>Simplify equations into formats more suited to analysis. |

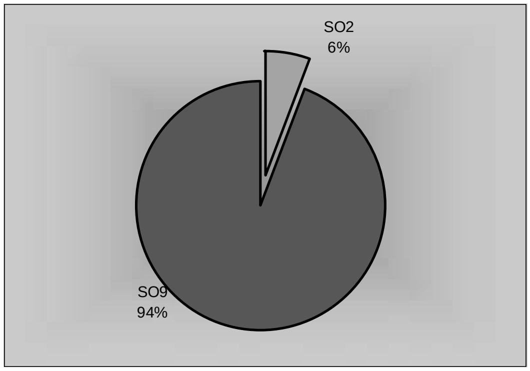



**Figure 4.2.10 Time spent on SO's in L 9**

### 4.2.11 Lesson No 11

A female teacher taught Grade 9 learners the topic of ***multiplication of sum and difference of two expressions*** for the duration of 38 minutes. She used the lecture method to teach this topic. Learners attempted to achieve two specific outcomes: SO2 and SO9. Learners' work was very neat.

**Breakdown of observation of Lesson 11**

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 4 min | Explains how to calculate ($x$ + 3) ($x$ – 3).<br>Questions and answers. | Listen and answer. | *SO2*<br>Facilitate ability to derive processes for a general rule. | |
| 5 min | Explains how to calculate (2$y$ – 9) (2$y$ + 9).<br>Explains how to calculate -4($x$ + 7) ($x$ – 7).<br>Questions and answers. | Listen and answer. | *SO2*<br>Facilitate ability to derive processes for a general rule.<br>**SO9** Facilitate ability to simplify expressions into a format more suited to analysis. | |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 2 min | Asks the learners to copy the examples. Goes around and marks the homework. | Copy the examples. | | *SO2*<br>Derive processes for a general rule. |
| 6 min | Gives class activity.<br>Simplify:<br>1. $(x + 1)(x - 1)$<br>2. $(x - 4)(x + 4)$<br>3. $(2x + 3)(2x - 3)$<br>4. $(a - 8b)(a + 8b)$<br>5. $(p - q)(p + q)$<br>6. $(a - b)(a + b)$<br>7. $(7x - 8y)(7x - 8y)$<br>8. $(2x - 3)(2x + 3)$<br>9. $(7y - 4)(7y + 4)$<br>10. $(3a + 5)(3a - 5)$.<br>Goes around, marks and corrects learners work. | Try the class activity individually. | | *SO2*<br>Derive processes for a general rule.<br>**SO9**<br>Simplify expressions into a format more suited to analysis. |
| 2 min | Corrects the misconception using $(x - 2)(x + 2)$ | Listen and answer. | **SO2** Facilitate ability to derive processes for a general rule. | |
| 12 min | Goes around, marks and corrects learners work. Some times corrects common mistakes on the board. | Try the class activity. Get help from the teacher. | | *SO2*<br>Derive processes for a general rule.<br>**SO9**<br>Simplify expressions into a format more suited to analysis. |
| 1 min | Explains Q4 on the board. | Listen and answer. | *SO2*<br>Facilitate ability to derive processes for a general rule.<br>**SO9**<br>Facilitate ability to simplify expressions into a format more suited to analysis. | |
| 2 min | Explains Q5 on the board.<br>Explains learners' mistakes and corrects them. | Listen and answer. | *SO2*<br>Facilitate ability to derive processes for a general rule.<br>**SO9**<br>Facilitate ability to simplify expressions into a format more suited to analysis. | |

| Time (min) | Teacher's Action | Learners' Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | Input | Outcome |
| 2 min | Writes down the homework.<br>Page 143 Ex 7.10 Q 1-18.<br>Asks the learners to spend only 18 minutes on homework. | Try the class activity.<br>Copy the homework details. | | *SO2*<br>Derive processes for a general rule.<br>**SO9**<br>Simplify expressions into a format more suited to analysis. |
| 2 min | Goes around, marks and corrects learners work. | Try the class activity.<br>Get help from the teacher. | | *SO2*<br>Derive processes for a general rule.<br>**SO9**<br>Simplify expressions into a format more suited to analysis. |

Comment: Exercise books are very neat and tidy.

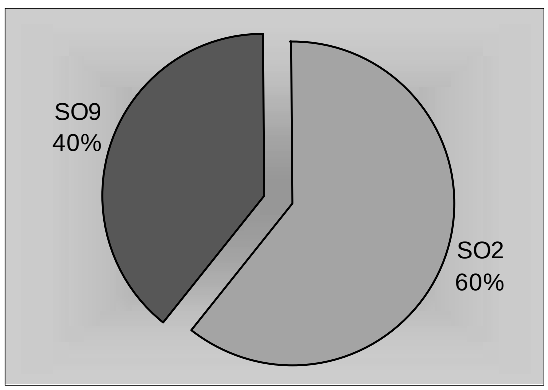



**Figure 4.2.11 Time spent on SO's in L 10**

## 4.3 Specific Outcomes in MLMMS

### 4.3.1 SO1: Demonstrate understanding about ways of working with numbers.

According to Curriculum 2005, SO1 is to demonstrate understanding about ways of working with numbers. The policy document on the National Curriculum 2005 elaborates that this outcome intends to extend the development of the number concept and the intuitive understanding of the number concept.

SO1 was not attempted in L5, L6, L8, L10 or L11 but it was attempted in all other lessons. More than one fifth of the total time in all eleven lessons was spent on input or outcomes to SO1.

### 4.3.2 SO2: Manipulate number patterns in different ways.

According to Curriculum 2005, mathematics has to involve observing, representing and investigating patterns in social and physical phenomena and within mathematical relationships. Mathematics must offer ways of thinking, structuring, organising and making sense of the world. SO2 has to assess these criteria.

In four out of eleven lessons, it was attempted to achieve SO2 as one of the outcomes. Less than fifteen percent of the time was spent on input or outcomes to SO2 in all eleven lessons.

### 4.3.3 SO3: Demonstrate understanding of the historical development of mathematics in various social and cultural contexts.

According to Curriculum 2005, mathematics is a human activity. All people have contributed to the development of mathematics. This outcome assesses the understanding of the historical background of the learners' communities' use of mathematics. In the eleven lessons observed no attempt was made to achieve this specific outcome.

### 4.3.4 SO4: Critically analyse how mathematical relationships are used in social, political and economic relations.

Curriculum 2005 explains its aim as to foster a critical outlook to enable learners to engage with issues that concern their lives individually, in their communities and beyond.

In none of the lessons observed did the teacher contribute to this outcome and learners therefore did not attempt to achieve it.

### 4.3.5 SO5: Measure with competence and confidence in a variety of contexts.

Measurement in mathematics is a skill for universal communication (Department of Education, RSA, 1997). Curriculum 2005 mentions as the aim for SO5 to familiarise learners with the appropriate skills of measurement, relevant units used, and issues of accuracy.

Two lessons attempted to achieve SO5 as one of the outcomes. The other nine lessons did not attempt to achieve SO5 as an outcome.

### 4.3.6 SO6: Use data from various contexts to make informed judgements.

Learners should understand how information is processed and translated into usable knowledge and learners should acquire these skills for critical encounter with information and make informed decisions (Department of Education, RSA, 1997). Out of the eleven lessons that were analysed, not a single lesson addressed or attempted to achieve this outcome.

### 4.3.7 SO7: Describe and represent experiences with shape, space, time and motion, using all available senses.

The policy document states that mathematics enhances and helps to formalise the ability to grasp, visualise and represent the space in which we live. It states further that in the real world, space and shape do not exist in isolation from motion and time. Learners should display an understanding of spatial sense and motion in time to achieve this outcome (Department of Education, RSA, 1997). Only in Lesson 6 time was spent (20%) on input or outcomes towards SO7.

### 4.3.8 SO8: Analyse natural forms, cultural products and processes as representations of shape, space and time.

The policy document states that the learners should be able to unravel, critically analyse and make sense of mathematical forms, relationships and processes (Department of Education, RSA, 1997). This outcome was not addressed or attempted in a single lesson.

### 4.3.9 SO9: Use mathematical language to communicate mathematical ideas, concepts, generalisations and thought processes.

It is essential to use mathematical language to communicate mathematical ideas and concepts. In ten lessons an attempt was made to achieve this outcome. Nearly half of the total teaching time was spent on addressing or attempting this outcome.

### 4.3.10 SO10: Use various logical processes to formulate, test and justify conjectures.

The policy document states that mathematics programmes should provide opportunities for learners to develop and employ their reasoning skills. It further mentions that learners need varied experiences to construct convincing arguments in problem settings and to evaluate the arguments of others (Department of Education, RSA, 1997).

Only two lessons addressed or attempted to achieve SO10. In Lesson 8 various problem-solving strategies were used.

### 4.3.11 Specific outcomes summary

| Specific outcome | Number of lessons in which SO was addressed* | Total amount of SO time as a percentage of total class time |
|---|---|---|
| SO1 | 5 | 23.4 |
| SO2 | 4 | 14.6 |
| SO3 | 0 | 0.0 |
| SO4 | 0 | 0.0 |
| SO5 | 2 | 13.2 |
| SO6 | 0 | 0.0 |
| SO7 | 1 | 1.7 |
| SO8 | 0 | 0.0 |
| SO9 | 10 | 42.5 |
| SO10 | 2 | 4.6 |

Table 4.3.11 Summary of outcomes in all eleven lessons.

Note: The number of lessons will not add up to eleven since more than one input/outcome can be addressed in a given lesson.

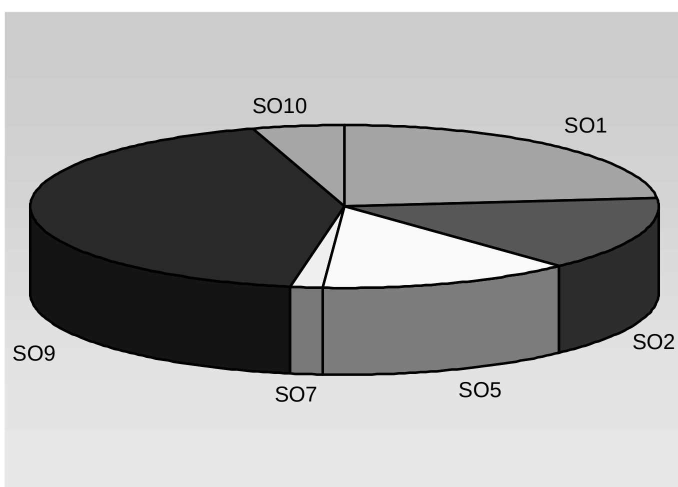



Figure 4.3.11 Total amount of SO time as a percentage of total class time

Although these eleven lessons are not necessarily representative of the full picture, this breakdown does give an idea of where the emphasis lies and which outcomes are largely unattended to.

### 4.4 Teacher's contribution and learners' achievement

Darling-Hammond (2000) found that the influence of well-prepared teachers on learner achievement could be stronger than the influences of learner background factors, such as poverty, language background, and minority status. Rogan (2004) in his case study mentioned that it is a misconception that when implementing C2005 teachers must not teach, but must facilitate. He further stated that learners have to be taught necessary skills to apply and these will not emerge from a group discussion. I prepared the table 4.4.1. in order to determine whether the teacher's contribution (input), which is the foundation laid by the teacher for the later realisation of outcomes, affect the outcomes as attempted or demonstrated by learners. It clearly explains the teachers' input time as a percentage of total class time (X) and learners' attempted or demonstrated outcomes time as a percentage of total class time (Y).

| Specific outcome | Number of lessons in which SO was addressed | Total amount of input time in minutes | Total amount of outcomes time in minutes | Total amount of input time as a percentage of total class time (X) | Total amount of outcomes time as a percentage of total class time (Y) |
|---|---|---|---|---|---|
| SO1 | 6 | 49 | 72.5 | 9.4 | 13.9 |
| SO2 | 4 | 38 | 38 | 7.3 | 7.3 |
| SO3 | 0 | 0 | 0 | 0.0 | 0.0 |
| SO4 | 0 | 0 | 0 | 0.0 | 0.0 |
| SO5 | 2 | 38 | 30.5 | 7.3 | 5.9 |
| SO6 | 0 | 0 | 0 | 0.0 | 0.0 |
| SO7 | 1 | 4.5 | 4.5 | 0.9 | 0.9 |
| SO8 | 0 | 0 | 0 | 0.0 | 0.0 |
| SO9 | 10 | 79 | 142 | 15.2 | 27.3 |
| SO10 | 2 | 7.5 | 16.5 | 1.4 | 3.2 |
| Total | | 216 | 304 | 41.5 | 58.5 |

Table 4.4.1 Summary of the time spent on input and outcomes in all eleven lessons.

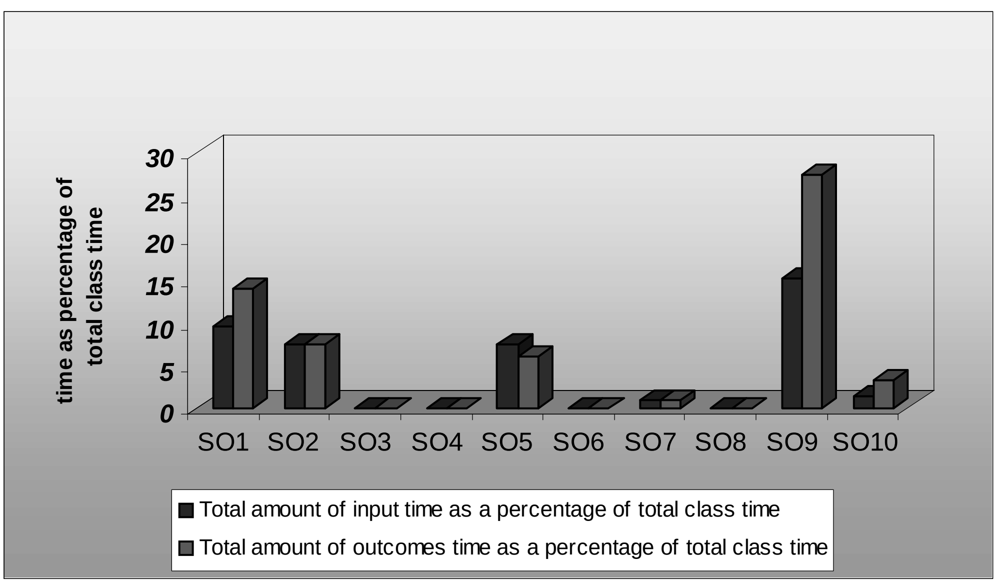



Figure 4.4.1 Relationship between input and outcomes time in eleven lessons

To determine the correlation between the teachers' contribution time (input time) and learners' time spent on attempting to achieve outcomes (outcomes time), I calculated the Pearson's product moment correlation coefficient. The obtained value is 0.8905.

This figure indicates that input time and outcomes time have a high positive correlation (Mulder, 1986). This figure is significant on a 1% level. Therefore there is a 99% certainty that there is a positive relationship between teachers' time spent on laying a foundation for the later realisation of outcomes and learners' spent time on attempting to achieve outcomes.

## 4.5 Conclusion

In this chapter research findings were explained and discussed. These finding are based on the analysis of video-taped lessons for which the systematic observation method was used. Conclusions were then drawn based on the analysis. These conclusions cannot be generalised, however, since only eleven lessons were chosen for the study. The findings are merely an indication of what are likely happen in different lessons with regard to teacher input and achievement of learning outcomes. Other limitations were that the study focuses on data from video-tapes and did not consider other types of measurements such as assessments and interviews of learners.

# CHAPTER FIVE

## QUALITATIVE REPORT ON CLASSROOM OBSERVATIONS

### 5.1 Introduction

In this chapter the data gained from observation of the events in the lessons are analysed qualitatively. The aim of this observation is to investigate the extent to which learners participated in the lessons and benefited from their seating arrangements and the teaching resources used. The aim is also to investigate the standard of the lesson content, the extent of understanding of the content as demonstrated by the teachers and learners as well as the teachers' and learners' questioning ability.

The important events in each lesson have been described under the heading 'Events in the lesson'. Under this heading particular events are described that might create misconceptions in the learners' minds, events not appropriate to the OBE curriculum, and also events not different from the past curriculum. The summary of each lesson includes some suggestions for improved implementation.

### 5.2. General observations (observations concerning all lessons)

#### Teaching approach

Most of the time educators used the traditional way of teaching, except that in most lessons the learners were sitting in groups. In most of these classes the teachers (still) used a teacher-centred approach rather than a learner-centred approach as recommended in Curriculum 2005. There was little evidence that teachers used appropriate teaching strategies to meet the learners' needs.

In most instances, the learners solved the problems in exactly the same way as the educator solved the problem. In most lessons the learners were told what to do and how to do it. In other words, when the learners had to solve a problem they followed the steps given by the educator.

In some lessons learners responded positively to most of the questions that were asked by the educators. In the majority of instances, learners responded by raising their hands to indicate that they knew the answers. Learners who did not raise their hands were neither given a chance to try and respond, nor were they invited to ask for clarity on the questions asked. It seems that in some cases learners merely came to school to passively listen to what the teacher had to teach them, not participating in the class activities.

In ten out of the eleven lessons, the teachers did not link their lessons to everyday life problems or to other subjects or topics. In Lesson 9, the teacher linked the lesson to three different topics, which is pleasing to notice. None of the teachers in these eleven lessons mentioned the purpose of studying the topic of the lesson, or where the learners could apply the knowledge gained from these lessons. Discovery and creativity were in general not encouraged in the lessons.

Learners in these eleven lessons learned mathematics in a language that is not their home language. This is the reason that in eight out of the eleven lessons, the teachers switched from English to their mother tongue when explaining the subject matter.

**Classroom organisation and management**

In all eleven lessons, learners were seated in one of two different ways, that is, in groups of six to nine learners, or individually in single desks facing the teacher. All of the classrooms observed had enough furniture such as tables or desks and chairs or benches but in one classroom there were not enough desks and benches. In this class three learners shared one bench that is meant to seat only two learners. During the lessons the educators managed to move around freely in the classrooms although in some classes there was little space. Generally, the classes were not overcrowded. During the lessons observed, the classrooms held between 40 to 65 learners. Only a few learners were given an opportunity to work on the chalkboard, which is understandable given the size of the class and the time frame of the lesson. The educators mostly seemed to manage teaching the bigger groups although in one lesson the educator was barely in control of the learners.

**Teaching methods**

In the eleven lessons two main teaching methods were used, namely

1) group work combined with the discussion method, and
2) the lecture method.

Generally, the teachers encouraged the learners more to mix and discuss the subject matter than in the past. In three lessons worksheets were distributed and these were used in two lessons.

OBE encourages teachers to use different strategies to explain the content. In ten out of the eleven lessons, however, only the ‘chalk and talk’ method was used. In the eleventh lesson the educator used the case study method to introduce the topic. In one geometry lesson, the teacher was using the protractor for drawing lines, not for measuring angles. He should have used the protractor to introduce the lesson in a different way so as to make the learners understand the fact that corresponding angles are always equal. OBE encourages teachers to use different strategies to explain the content.

**Teaching resources and equipment**

In most of the lessons no teaching resources other than the chalkboard were used. In one lesson, the teacher used the textbook to copy the problems onto the chalkboard. No new resources such as teaching technology were present in these classes. No calculators were present in the lessons observed. Even in the geometry lessons, the actual mathematical instruments needed were mostly absent.

In the past, each learner used to have a textbook. In the lessons observed, in nine out of the eleven observed lessons, the learners did not have a textbook. The learners only had exercise books for class work. In some lessons, learners wrote on loose sheets of paper. In one lesson the topic was graphs but not a single learner had graph paper.

**Learners' involvement and behaviour**

In the lessons, only one-way communication took place most of the time. In no lesson did the learners ask the educator questions, and in no lesson did the educator encourage learners to ask questions.

In none of the eleven lessons did the teachers encourage the quieter learners to contribute. It seemed that many learners avoided active participation, as their more confident peers were likely to volunteer their solutions or do the solution on the board. There were learners who did volunteer but did not have an opportunity to give the answers or do the problems on the board. Given the size of the class and the time frame of the lesson, it is understandable that it is difficult to give each learner an opportunity to give the answers or do the problems on the board.

In most lessons the educator asked questions but never nominated a learner to answer. The learners who knew the answers would answer in chorus but teachers did not encourage the quieter learners to contribute.

Learners were eager to go to the chalkboard to solve the problems. Some answers to the teachers' questions illustrate the lack of clarity in learners' minds. If the teacher requested for a solution strategy, learners would simply state the answer and they found it difficult to justify their answers.

In most lessons the learners behaved well barring a few incidents. In one incident (in Lesson 2) one learner simplified the expression $12x^0$ wrongly on the chalkboard as $12x^0 = x^{1-1} = x^0 = 1$. The teacher said it was wrong and the learner changed $x^{1-1}$ to $x^{1+1}$. The whole class laughed but the teacher did not take any action.

**Content standard**

The new curriculum framework encourages teachers to choose content that is relevant to the needs and abilities of their learners. Having said this, in two lessons the content standard was far too low for the learners. In most of the other lessons the standard was fairly low.

As mentioned before, all teachers observed found it difficult to connect the topics they taught to everyday life problems.

**Group Work**

In nine of the eleven classrooms, the desks were clustered to allow for group work. In four lessons teachers encouraged co-operative learning, in another three of these lessons the learners spent considerable time working alone and in two of these lessons no meaningful group-interaction occurred, that is, any discussion taking part was not about the subject content. In two lessons co-operative learning was discouraged. In one lesson the clustered seating arrangement caused restlessness and noise amongst the learners. In this lesson learners were discussing matters other than the subject content.

The learners in the lessons, who were forced by the teachers into co-operative learning, were more actively involved in the learning process compared to those in lessons in which this was not the case.

## 5.3 Specific Observations in lessons.

### 5.3.1 Lesson No 1

A female teacher was teaching the topic of ***addition and subtraction of fractions*** to Grade 9 learners. She rearranged the class into groups of six.

**Events in the lesson**

In the beginning she mentioned that the learners were supposed to do multiplication and division, but since there were problems in the previous day's lesson she wanted to continue to teach addition and subtraction. In the past the teacher would just follow the lesson scheme as it was set out. It is a good sign that the teacher realised there was a problem and attempted to rectify this by repeating the lesson. In actual fact, the lesson did not seem to be a continuation; rather it had the appearance of an introduction to addition and subtraction.

With regard to the first problem, she explained that the learners have to calculate lowest common multiples. The learners knew how to get the answers but could not explain how they derived the answers, for instance:

Teacher: "What is the L.C.M. of 4 and 6?"

Learner: "12"

Teacher: "How do you come to that 12?"

Learners: Silence

Not a single learner was able to answer this question.

It seems they knew the answer but did not know how to explain it. In OBE the learners have to explain their actions. This did not happen in this class.

**Teacher's contribution**

In the past some teachers spent most of their time writing on the chalkboard or sitting behind a desk. In this lesson the teacher was moving around the class and discussed the problems with the learners.

**Learner participation**

Learners were actively involved in the learning process. They were discussing among themselves. They were willing to go and work on the chalkboard. They were willing to answer the questions asked by the teacher, but did not ask any questions themselves. They were very eager to learn.

## Content standard

As said earlier, the new curriculum framework encourages teachers to choose content that is relevant to the needs and abilities of their learners. In this lesson the content is simple fractions and L.C.M., which is of a very low standard for Grade 9 learners. Even though, as seen in the quantitative analysis in the previous chapter, in this lesson the learners addressed specific outcomes SO1 and SO9, this might not be such a valid achievement since the standard of the outcomes was very low. The reason behind this discrepancy might be that in the Curriculum 2005 the content standard is not specified in detail.

## Teaching resources

Apart from the chalkboard and the chalk, no other teaching resources were used. There was not even a single textbook or any other teaching material in the class.

**Summary**

In terms of explanation and teaching resources the learners were jumping from one frying pan into another frying pan. But in terms of participation and eagerness to learn, the situation was definitely improving after introducing Curriculum 2005. Whether the reason for this eagerness lies in OBE or in the fact that learners have become motivated by the political changes in the country, is not clear.

### 5.3.2 Lesson No 2

A male teacher was teaching the topic of ***zero as an exponent*** to Grade 8 learners. The class was already arranged in groups.

**Events in the lesson**

The teacher started the lesson with the question.

Teacher: “What is an exponent?”

Learners: “That is the power.”
Then he wrote two examples:
$3 \times 3 \times 3 = 3^3$

$5 \times 5 \times 5 = 5^3$

He mentioned the superscript as an exponent and made the statement "I believe you understand what an exponent is". The example could cause confusion with the learners in terms of their understanding of exponents because in both examples the power was 3. It might well be that based on the chosen example, some of the learners might have understood, for instance, that any base to the power of 3 is called an exponent. Next the teacher jumped to the division of exponents with variables as base.

This introduction is no different from the lessons I observed in the past as a college lecturer. In other words, despite OBE the teaching technique to introduce the lesson has not changed.

In another example, the teacher wrote $2^3 \div 2^3 = 2^{3-3} = 2^0$

Then the following conversation took place in the lesson:

Teacher: "$2^0$ is equal to …"

Learners: Some two, others zero.

Teacher: "I am saying it is equal to one".

OBE requires that the learners should derive the formula but here the teacher was already stating that $2^0$ is equal to 1 without any explanation. Then he moved to the next example.

In the next example the teacher started to prove that $3^0$ is equal to 1.

He did not use any examples with variables as a base and yet he gave the class an activity with variables as bases.

While the teacher was explaining one problem (m $\div$ m) in the activity, the learners found the correct answer through a different method, upon which he stated that it was incorrect. He did not mention, however, whether the method was incorrect or whether the answer was incorrect, and he continued saying "This is not what I want."

The OBE curriculum encourages learners to be creative and find different ways of solving problems. But in this lesson the learners' creativity was discouraged without explanation.

### Teacher's contribution

In this lesson the teacher moved around the class discussing the learners' problems. He did not use any teaching resources to explain the topic. He did not make clear how the knowledge they gained from the lesson could be applied to solve everyday problems.

### Learner participation

Learners participated well in this lesson. They were eager to learn, themselves, but they did not encourage other learners.

### Content standard

The standard was appropriate for Grade 8. However, the teacher did not link the topic to everyday life problems.

### Teaching resources

Apart from the chalkboard and one copy of the teacher's textbook, no teaching resources were used in this lesson. There was no other teaching material present in the class.

### Summary

This lesson was not different from lessons based on the old curriculum. In the previous chapter it was indicated that the learners spent time to achieve two specific outcomes, which is good, but not much different from the past. Because the teacher's approach had not changed and because no new teaching resources were used, and no link was made between the topic in class and the learners' lives, we will have to conclude that not much has changed.

### 5.3.3 Lesson No 3

A male teacher was teaching the topic of ***parallel lines*** to Grade 8 learners. The class was arranged with single desks and chairs – learners were facing the teacher.

**Events in the lesson**

The teacher drew four points lying in a straight line using the protractor. He asked the learners to do the same. They were using rulers. He then asked them to draw another two points 3 cm below the line. Over and over he said that they must measure the 3 cm distance and connect the points. He mentioned that this means that these two lines are equidistant. What he said is correct but the construction is not correct. For lines to be equidistant they must be parallel. He has to draw perpendicular lines and measure the distance 3cm and draw the second line. The way he did it might well have created some misconception in the learners.

He called the first line *AT* and the second line as *BX*. He asked them to state that *AT* is parallel to *BX*. In real life it is not possible, however, to draw parallel lines using only one ruler or one protractor as a ruler without a measuring angle. The following conversation proves that the way he introduced this concept created confusion about parallel lines.

Teacher: "*AT* is parallel to *BX*. Say it."

Learners: "*AT* is parallel to *BX*"

Teacher: "What made these two lines to be parallel?"

Learner: "Both lines are equal."

Teacher: "Why are they parallel?"

Learner: "They are equal and parallel."

Teacher: "When you measure this distance what do you get?" (He meant the distance between *AB* and *TX*)

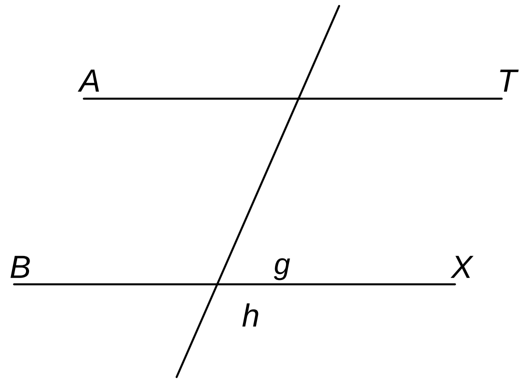
Learner: "They are equal."

Teacher: "They are equidistant."

He used his arms as a teaching resource and explained the concept of equidistance.

Later in the lesson he created more misconceptions. He mentioned that the properties of parallel lines were 1. Corresponding angles 2. Alternate interior angles 3. Co-interior angles.

He drew the diagram (see below) and marked the angles.




His aim was to teach corresponding angles, alternate interior angles and co-interior angles.

Teacher: "From the properties of parallel lines the corresponding angles are represented by letter *F*, alternate angles are represented by letter *Z*, co-interior angles represented by letter *C*."

Teacher: "Who can tell me corresponding angles? Where do you see *F* here?" He indicated the diagram.

Learner: "*d* and *h*"

Teacher: "Corresponding angles are equal."

The teacher did not say why they were equal and he did not prove that they were equal. According to the OBE curriculum the teacher has to explain his facts with proof but in this lesson, like in the past, the teacher merely mentioned without giving any explanation that corresponding angles were equal. He did the same for alternate angles and co-interior angles. Admittedly, from the observation it became clear that the learners were very clever to glean the correct facts from this lesson.

**Teacher's contribution**

The teacher discouraged the learners to discover the facts. He merely gave the facts for them to memorise without understanding. He did not encourage co-operative learning either.

**Learner participation**

The learners were very eager to learn. They participated well in the class.

**Content standard**

The standard is appropriate for the learners but the way the content was presented was not appropriate in terms of OBE outcomes.

**Teaching resources**

Mathematical instruments were used but not in a proper way for learners to understand the topic.

**Summary**

This lesson was another example of a traditional way of teaching. The teacher's content knowledge was poor. He was not certain that co-interior angles are supplementary. Whether this particular teacher actually needs further content development and training in teaching methodology needs to be investigated.

### 5.3.4 Lesson No 4

A male teacher was teaching the topic of ***algebraic fractions*** to Grade 9 learners. The learners were seated in groups of 9. The class was short on desks and benches. There was enough classroom space to accommodate all learners. The teacher used the chalk-and-talk method.

**Events in the lesson**

The teacher used the wrong terminology to explain the topic. Instead of 'highest common factor' he repeatedly asked what was the 'common factor'. It caused some confusion, which hindered the learners in the understanding of the teacher's explanation.

For example, as a result of simplifying $\frac{2x^2+2x}{2x}$ the learners got two different answers as follows.

Answer 1: $\frac{x^2+x}{x}$

Answer 2: $x + 1$

**Teacher's contribution**

The teacher was not in control of the class. The learners made a lot of noise. It was clear that they were not focusing on the subject matter. The teacher's teaching style had not changed from that in the past.

**Learner participation**

Very few learners were committed to their work in class. Some of them wasted their time by looking at the camera all the time. The learners were not mature enough to be in a Grade 9 mathematic class. It is unclear whether the cause for this lay with this particular teacher or with the environment. This needs further investigation.

**Content standard**

The standard was suitable for Grade 9 learners but the way it was presented was not acceptable for Curriculum 2005.

**Teaching resources**

The teacher and some learners had textbooks. Apart from these, there were no other teaching or learning resources available in the class.

**Summary**

As reported in the previous chapter, the learners addressed three specific outcomes, which are SO1, SO9 and SO10. Yet, they attained very little knowledge from this lesson that they could apply in future.

### 5.3.5 Lesson No 5

A male teacher was teaching the topic of ***factorisation*** to Grade 8 learners. The class had enough desks and chairs for all learners. The learners were seated in groups.

**Events in the lesson**

The lesson was 45 minutes long. Out of these 45 minutes the teacher spent the first 23 minutes doing corrections of the five problems given as homework. Six learners did the problems on the board, one after the other. When the learners finished the problems the teacher would only ask whether it was correct. If any learner said it was wrong, then he sent the learner to do the correction on the board. He never explained what went wrong in the learner's work.

Even though the learners sat in groups, very little group learning or team learning took place in this class. The seating arrangement did, however, present a very good opportunity to make noise. This class is an example of how a class with a cluster seating arrangement can go wrong if the teacher is not in control of the class.

These learners' basic knowledge was below average. For example, the teacher gave the expression $a(x - y) + x - y$ to factorise. This is the conversation that took place between the teacher and learners:

Teacher: "What is the H.C.F? Is $x - y$ common?"

Learners: Talking amongst themselves. No answer.

Teacher: "OK. How many terms are there?"

Learners: No answer.
The teacher explained that there were three terms in the expression.

Teacher: "What is the H.C.F. of these three terms?'

Learners: Some "plus", some "minus", some "minus y".

The OBE curriculum encourages learners to know the reasoning behind the answers but in this class the learners did not even know the answers for many of the questions.

**Teacher's contribution**

In this class there was no order and no discipline. Most of the time the teacher asked questions and answered them himself. The teacher has to act as a leader to guide the learners, but in this lesson the teacher was not doing this at all. He did not check whether all learners were participating in the lesson. The teacher spent 23 minutes of the lesson on correcting homework. When I looked at the tape again and again I realised that the main cause of the problem in this class was the teacher. Whether the teacher needs further training needs investigation.

**Learner participation**

Most of the learners had no idea what was going in the class and they did not want to find out. When they answered questions, they would do so in chorus. No individual learners raised a hand in this lesson.

**Content standard**

The content standard was appropriate for the grade. But the content was not presented well to the learners. Like in the past, the teacher did a few problems and answers on the board. Where and how learners could apply the content or the purpose of learning this specific content was not mentioned in the class.

**Teaching resources**

Apart from the chalkboard and the duster, there were no other teaching resources. The teacher did not possess a textbook.

**Summary**

Very few learners concentrated on the lesson. Even though the learners addressed two specific outcomes, as can be seen in the previous chapter, it is hard to say whether learners attained any knowledge from this lesson. It seems that most learners did not learn anything worthwhile. This lesson is evidence that teachers need further training in Curriculum 2005, and in particular in teaching methodology.

### 5.3.6 Lesson No 6

A male teacher was teaching the topic of ***linear graphs*** to Grade 9 learners. Learners were seated in groups.

**Events in the lesson**

The first eleven minutes were spent on doing homework and marking of homework. But this time was well spent. The learners lacked basic knowledge. At one stage they had to multiply –2 by 1. This is the conversation that took place:

Teacher: “minus two multiply by one”.

Only a few learners raised their hands.

Learner1 : “plus two”

Teacher : “Wrong”

Learner2: “minus two”

The teacher continued solving the problem. But he did not focus on the wrong answer and he did not give an explanation to the learners who did not raise their hands. Although his topic was linear graphs, he could have spent a few minutes on correcting their misconception that $-2 \times 1 = +2$.

This misconception regarding 'minus' occurred many times during the lesson. In another instance he was teaching about the linear function $y = mx + c$ and he explained what $m$ and $c$ represent. Next, he wrote the equation $y = -2x + 4$. The following conversation took place:

Teacher: "Quickly say, what is our *m*?"
He meant the value of $m$ in the equation $y = mx + c$.

Learner1: "two"

Teacher: "What is *m*?"

Learner2: "minus two *x*"

No single learner could give the correct answer.

Teacher: "It is minus two."

The confusion regarding *positive* and *negative* went on even while sketching the graphs. The teacher drew the *X*-axis and the *Y*-axis with explanation. Then he marked the point of intersection of the graph and the y-axis as (0, 4) and asked learners to come and draw the slope of the graph. No learner was willing to go to the chalkboard. The teacher then called one learner and the learner drew the positive slope. Then the teacher explained the different between the positive slope and the negative slope.

**Teacher's contribution**

Despite the size of the class and the time frame of the lesson, the teacher managed to check most of the learners' exercise books. He encouraged group work. He also encouraged learners to assist other learners. His content knowledge was good. It gave him confidence in interacting with the learners. He held the attention of the learners throughout the lesson. He tried to eliminate the learners' confusion over "+" and "–".

**Learner participation**

Learners were participating well. While one learner was doing the problem, others were listening and paying attention. Learners behaved very well. When the teacher asked the question, the learners raised their hands. Unlike the previous lesson, these learners did not answer in a chorus. Even the learner writing on the board involved other learners. Learner-to-learner communication was clearly present in this lesson.

**Content standard**

The standard of the content was suitable for Grade 9 learners.

**Teaching resources**

Apart from the chalk, chalkboard and duster, there were no any other teaching resources. Even the teacher did not have a textbook. Learners were learning about graphs, but graph paper was not available in the class.

**Summary**

From the quantitative analysis we did in the previous chapter it is clear that this lesson focused on three specific outcomes, which are SO2, SO7 and SO9. The qualitative observation also proves that the learners addressed the outcomes of the lesson. The teacher never linked these outcomes to daily life, he could have spent a few minutes discussing the importance of graphs in our daily lives.

**5.3.7 Lesson No 7**

A male teacher was teaching the topic of ***BODMAS*** to Grade 8 learners. Learners were seated groups of six (double desks and chairs). There were enough desks and chairs in the classroom. The size of the classroom was large enough to accommodate all learners.

**Events in the lesson**

The teacher introduced the lesson with the question "What is BODMAS?"
One learner replied that BODMAS was all the operation signs.

The teacher explained that when you simplify an expression you have to follow this order and he wrote on the board vertically:

$$B \rightarrow O \rightarrow D \rightarrow M \rightarrow A \rightarrow S$$

This might have created a misconception with the learners because the correct way is:

$$B \rightarrow O \rightarrow DM \rightarrow AS$$

He then distributed worksheets. It contained five fraction problems. Learners tried the problems on the worksheet as a group. The teacher went around and helped the learners. Each group reported (that means the group leader did it on the board) on one problem. One of the problems in the worksheet was "2/3 × (¾ ÷ ½) of 2". One learner did the problem on the board. Another learner went and corrected it. The teacher clearly explained what went wrong in the learner's work.

**Teacher's contribution**

The teacher facilitated the class well. The teacher encouraged teamwork. Despite what the OBE curriculum expects, no new teaching methodology was used in the class except group work and a worksheet with five fraction problems written on it.

**Learner participation**

Learners were very confident. The good learner to educator relationship was clearly present in the class.

**Content standard**

The content standard was suitable for Grade 8 learners.

**Teaching resources**

Except the chalkboard, duster, worksheets (above mentioned) there were no other teaching or learning resources available in the class. Not a single learner had a calculator in the class.

**Summary**

From the quantitative analysis in the previous chapter it is clear that the learners spent the lesson time on two specific outcomes, which are SO1 and SO9. Apart from the group work, I did not observe any difference between what was done in the past and the OBE way the Curriculum 2005 was taught.

### 5.3.8 Lesson No 8

A female teacher was teaching the topic of ***angles around a point*** to Grade 8 learners. The learners were seated in groups in tables and chairs.

**Events in the lesson**

This lesson, however, did not look like a continuation but she might have taught the topic prior to this lesson. The teacher introduced the lesson by asking about the size of a right angle. She then continued her introduction by introducing the protractor and its usage. Some learners had a problem to use the protractor. So for the remainder of lesson the teacher and learners did not use the protractor.

The teacher taught the class to calculate the angle using two different methods. In one instance she asked the learners which method they preferred to use for their calculation. Only very few learners raised their hands to answer this question. Looking at the expression on their faces, it is unclear whether they found it difficult to choose, or whether they did not understand one or both methods. It will raise the question whether they were really achieving their outcomes. She asked the learners to attempt problems that were very similar to her examples as a class exercise.

**Teacher's contribution**

The teacher did not encourage the learners to use the protractor. The teaching method was not different from that in the past except for the group work. The teacher did not contribute to the learners' understanding of how to analyse the different types of problems. She did not check their work. She did not even ask for the answers to the problems.

**Learner participation**

Learners participated well. They did their calculations manually.

**Content standard**

The standard was suitable for Grade 8 but the teaching method was not suitable for the OBE curriculum.

**Teaching resources**

Learners did not have a mathematical instrument box or calculators on their tables. Only the teacher had a protractor.

**Summary**

This lesson was another example of 'jumping out of one frying pan into another or perhaps not jumping at all'. The topic was ideally suited for a very practical type of lesson but in the class no discovery method was applied.

### 5.3.9 Lesson No 9

A male teacher was teaching the topic of ***word problems*** to Grade 8 learners. The class suffered a shortage of tables. Learners were sitting in groups.

Events in the lesson

The teacher focused on three word problems. He used geometric diagrams to explain the topic. He carefully selected the examples that contained word problems, fractions and basic geometry. The teacher's explanations were loud, clear and correct. It seemed he was determined to teach the learners. Apart from the content standard, it was difficult to fault anything.

**Teacher's contribution**

The teaching method was very good. He made the relationship between the three different topics in this lesson very clear.

**Learner participation**

The learners behaved well and seemed eager to learn. They participated well in the learning process.

**Content standard**

The content standard was too low for Grade 8 learners.

**Teaching resources**

Only worksheets were available in the class, no textbooks or other teaching resources. Despite this shortcoming, the teacher taught the topics well.

**Summary**

From the previous chapter it is clear that the learners spent their lesson time on specific outcomes SO9 and SO1. The qualitative observation supports the quantitative findings. In comparison with accepted teaching methods of the past, the teaching method employed in this lesson has improved. Learners showed a clear cooperative attitude, which is another improvement. This lesson could definitely be classified as 'jumping from the frying pan into a better place'. The only worrying aspect is the low standard of the content taught.

**5.3.10 Lesson No 10**

A female teacher was teaching the topic of ***solving equations*** to Grade 9 learners. Learners were seated in groups.

**Events in the lesson**

The first four minutes were spent on remedial work on factorisation. Learners were doing problems on the board. There was no order in the class. Most learners did not concentrate on learning. The lesson was a waste of time.

The teacher began the introduction of the topic by explaining what an equation is. She mentioned that an equation is composed of three elements which are RHS, LHS and = sign. She explained this concept by solving two examples: $2p - 2 = 6$ and $x/3 - 7 = 14$. Then she wrote another one on the board: $2x + 19 = 21$, which is similar to the earlier examples. She then invited any learner to come and solve this problem on the chalkboard. At first no learner volunteered. Then two hands were raised. The problem on the board was suitable standard for Grade 9 learners to tackle. The question is whether the learners did not understand the topic or whether they were shy to go to the board.

Teacher’s contribution

The teacher’s contribution to learning was minimal. She selected very simple examples of equations. Most of the time the learners were doing the problems and she did not contribute.

**Learner participation**

It seemed that the learners were used to this kind of teaching and learning. That is probably why their standard is very low for Grade 9 learners.

**Content standard**

The topic was suitable for Grade 9 learners but the examples and exercises were not. The standard was low for Grade 9 learners.

**Teaching resources**

The teacher had a textbook. Learners did not have any textbooks on their tables. The teacher wrote the page number of the textbook and the numbers of the questions as homework. From this I assumed that the learners did have textbooks but not with them. No calculators were visible in the class.

**Summary**

Even though from the previous chapter the learners spent lesson time on two specific outcomes, this lesson was another example of the notion that except for the seating arrangement little has changed when the new curriculum was implemented.

### 5.3.11 Lesson No 11

A female teacher was teaching Grade 9 learners. The classroom was arranged with double desks and chairs facing the teacher and the chalkboard. The teacher wrote the topic ***'multiplication of sum and difference of two terms'*** on the chalkboard.

**Events in the lesson**

The teacher instructed the learners to use fixed steps without the explanation. For example, learners have to simplify $(x - 7)(x + 7)$ in exactly two steps. She did not explain the reason for her way of solving the problem. This means that, actually, the class was meant to engage in rote learning. Other evidence of this is that when she asked questions she expected the class to answer in a chorus.

**Teacher's contribution**

She was moulding the learners to find the same type of response to the same type of problems. The teacher held the attention of the learners throughout the lesson by asking questions. This is an example of a rote-learning lesson.

**Learner participation**

The learners were very eager to learn and their work in the exercise books was very neat.

**Content standard**

The content was appropriate for Grade 9 learners but the teacher's way of presenting the content was not at all suitable for OBE.

**Teaching resources**

Apart from a few textbooks there were no other teaching resources available in the class. No calculators were to be seen on the video recording. When learners had to find the answer to 4 x 49, they did this on paper.

**Summary**

This lesson was in no way different from the lessons of the past, including the seating arrangements. This teacher needs extra training in Curriculum 2005. She does possess the content knowledge, but she needs to engage in appropriate teaching methodology. In this lesson the learners were simply memorising the steps to take to solve a particular problem.

## 5.4 Conclusion

In the previous chapter the data were analysed in mostly a quantitative manner. In this chapter the same data were analysed in a qualitative manner. The most important events in the lessons were discussed in detail. Since this study is based on eleven videotaped lessons, the findings must be regarded as an indication of what might take place in different types of mathematics lessons in terms of content of the lessons, organization of learners, availability of teaching resources, learners' behaviours, their discipline in class and other matters.

# CHAPTER SIX

## FINDINGS AND CONCLUSIONS

### 6.1 Introduction

In this chapter, I attempt to answer the research questions based on findings of the study, draw conclusions and make recommendations for further study. Findings were compared with that of their practice before Curriculum 2005 was introduced in the former Department of Education and Training (DET) schools in South Africa.

### 6.2 Findings

The section below groups the findings with respect to the research questions. This is done so as to break the data into manageable themes for analysing.

#### 6.2.1 To what extent are the mathematics learning outcomes mentioned in the intended Curriculum 2005 addressed or attempted by the learners and/or by the educators?

Outcomes SO3, SO4, SO6 and SO8 were neither addressed nor attempted in any of these eleven lessons. In addition, in some lessons the standard of the outcomes attempted was not high enough for Grade 8 and 9 learners. In the eleven lessons more than 23% of the time was spent on specific outcome SO1. Yet, in most of these lessons the level at which the outcome was addressed was very low. Also, although more than 43% of the time was spent on specific outcome SO9, nearly half of the time was spent on sharing observations, i.e. on communication and not on mathematics.

Individual outcomes are now discussed:

Outcome SO3, which is to *demonstrate understanding of the historical development of mathematics in various social and cultural contexts,* was not addressed by the teachers in any of these eleven lessons. Neither did teachers select suitable examples to address specific outcome SO3 in their lessons. Such examples could possibly have been used to make them feel more at ease with the subject and so remove the fear of mathematics in their minds. Yet the opportunity was missed.

Outcome SO4, which is to *critically analyse how mathematical relationships are used in social, political and economic relations,* was not addressed in any of the eleven lessons. The lessons were not connected to everyday life or to any other subject, just as often happened in the past. With the exception of one lesson, learners were learning mathematics as a subject that was not used in their lives or applied anywhere else.

Outcome SO6, which is to u*se data from various contexts to make informed judgements,* was not attempted in any of the eleven lessons. This outcome expects the learners to understand how information is processed and translated into usable knowledge. They should acquire these skills for critical encounters with information and make informed decisions (Department of Education, RSA, 1997). Not a single teacher contributed to this outcome.

Outcome SO8, which is to *analyse natural forms, cultural products and processes as representations of shape, space and time*, was not attempted in these eleven lessons. The Policy document (Department of Education, RSA, 1997) states that the mathematical forms, relationships and processes embedded in the natural world and in cultural representations are often unrecognised or suppressed. That is why the policy document further states that the learners should be able to unravel, critically analyse and make sense of these forms, relationships and processes. In all these eleven lessons this outcome was suppressed or not recognised.

Outcome SO10, which is to u*se various logical processes to formulate, test and justify conjectures,* is a very important outcome for those who want to study further in science and in fields such as information technology. It was addressed in only two lessons, but not appropriately. Not enough time was spent on achieving the outcome. In total less than five percent of the time was spent on this outcome.

Understandably, it is not possible to attempt to achieve all ten outcomes in one single lesson. It is disturbing, however, that important outcomes such as SO3, SO4, SO6, and SO8 were not attempted in any of the lessons and very little time was spent on SO10. Other outcomes achieved in these eleven lessons were also achieved in the traditional curriculum in the past. This is a clear indication that by introducing Curriculum 2005 the learners' knowledge, understanding, skills and values had very little opportunity of changing.

In all the observed classes, teaching materials were either non-existent or insufficient for addressing the specific outcomes. Textbooks were insufficient in these lessons. No new resources from technology or from the environment were present in these classes except in three lessons where worksheets were distributed and used in only two. No calculators or mathematical instruments were available whenever needed in these lessons as a teaching or learning material aid. In one classroom there were not enough desks and benches. It may hinder the achievement of the outcomes.

Regarding the teaching resources, in most of the classes very little has changed after introduction of Curriculum 2005. Because of my experience as a college educator, I am aware that in the past most educators never touched the critical analysis part in mathematics. I find it hard to see the difference between these eleven lessons and the ones I observed in the past as a teacher trainer. It is also disturbing that the actual planning of lessons did not improve.

Moreover, it was alarming to see the gaps in the educators' content knowledge. Some teachers were not confident in their subject matter. One teacher was relying on the learners for some answers. This is a factor of great concern for achievement of general and specific outcomes mentioned in Curriculum 2005 by the learners.

The literature review (Chapter 2) revealed (Geddert, 1993; Mason, 1998; Riordan and

Noyce, 2001; Hiebert, 1999; King et al. 1992; Reys et al. 2001; Kahle et al. 2000) that in many cases after introducing the OBE the amount of achievement in learning outcomes improved. My findings disagree. The reason might be that it was not implemented properly in this particular setting.

### 6.2.2 Is there any relationship between teachers' contribution (input), which is the foundation laid by the teacher for the later realisation of outcomes, and outcomes as attempted or demonstrated by learners?

The educators spent time to lay a foundation for the attempted outcomes SO1, SO2, SO5, SO7, SO9 and SO10. In turn learners spent time on attempting to achieve these outcomes. Of course, learners did not attempt to achieve any outcome if the teachers did not lay the foundation.

In the eleven lessons more than 65% of the total teaching time was spent on SO1 and SO9 in terms of input and/or outcome. In these lessons SO3, SO4, SO6 and SO8 were not attempted, or no input was given to these outcomes. Less than 2% of the total teaching time was spent on SO7 in terms of input and/or outcome. Less than 5% of the total teaching time was spent on SO10 in terms of input and/or outcomes.

In Chapter 4, we found a positive correlation between time spent by the teacher to lay a foundation and the time spent by the learners on attempting to achieve the outcome. The evidence generated from the research findings explicitly confirm that there is a positive relationship between the teachers' contribution and learners' willingness to attempt achieving outcomes in all eleven lessons.

### 6.2.3 What kinds of teaching strategies are used in attempting to achieve the learning outcomes?

The Department of Education (Department of Education, RSA, 1997) states that the learners' needs should be met through different teaching strategies. Curriculum 2005 lays down the vision for education to step away from rote learning and teaching without knowing the purpose of learning. Compared to past practices, teaching strategies have slightly improved. For instance, in some classes educators encouraged learners to discuss the problems. In some lessons, they were encouraged to analyse the problem from a different angle. In one lesson a case study was introduced. In other words, learners were motivated to play an active role in most of the lessons. Some learners felt confident enough to try and solve a problem on the chalkboard.

In other lessons the teachers did a number of problems and learners did exactly the same type of problems with the same number of steps without the clear picture of why and what they were doing. OBE encourages learners to choose different methods, combine them, discuss these with their peers and go through productive learning experiences. It was also noticeable that not many different teaching methods were used.

Standards-based education suggests that the learners should first understand the procedures before practising them. It is further suggested that learners should apply those procedures in their daily lives. There is little encouragement in these lessons by the teachers for the learners to apply mathematical procedures in their everyday lives. The NCTM Standards recommend that the curriculum should place emphasis on problem solving, reasoning, making connections between mathematical topics, communicating mathematical ideas and providing an opportunity for all to learn (NCTM, 1989, 1991, 1995, 2000). These criteria pose an ideal situation but in reality there is little evidence of making connections between mathematical topics etc. None of these lessons, except Lesson 9, were connected to learners' real life world. These lessons were not connected to their everyday life or to any other learning area although Curriculum 2005 emphasises integrated teaching.

I found that group work took place in most lessons, much more so than in the past. In most of the classes the seating arrangements were changed and in some classes the teachers encouraged co-operative learning. Yet, although learners were mostly seated in groups, there were also instances where learners were not encouraged by the teacher to do group work. The group work method allows the learners to be more actively involved in the class than in the past but in some classes it resulted in the learners being noisy and not concentrating. One of these eleven lessons is an example of how the cluster seating arrangement can go wrong if the teacher is not in control of the class.

According to Kahle, Meece and Scantlebury (2000) standards-based teaching practices positively influence the science achievements and attitudes of urban African-American learners. Yet, in the observed lessons a positive attitude towards learning was hardly observed in learners in some classes. In some lessons the teacher was barely in control of the learners.

The learners' confidence has improved in general. This is perhaps because the group work method was applied appropriately in most classes. On the other hand, I noticed only a slight change in the content knowledge of the majority of the learners at the end of each lesson. The reason for this is that educators merely touch on very basic outcomes. It seems that the level of the educators' own content knowledge is problematic. OBE gives a great deal of freedom to select the content and the appropriate teaching method to achieve the specific outcomes. The majority of teachers either displayed a lack of content knowledge or did not select the appropriate teaching method. Because teachers are not confident enough of their content knowledge they do not encourage learners to ask questions. In fact, not a single teacher encouraged the learners to ask questions. In general, teachers fail to create an exciting opportunity for learners to learn mathematics and therefore fail to motivate learners.

Some of the lessons were teacher-centred and not learner-centred. Some teachers displayed a lack of leadership that resulted in an undisciplined environment where no proper learning could take place. Only one-way communication took place in these lessons.

## 6.3 Conclusions of the study

*On outcomes-based education:*

The observed lessons were not meaningfully different from lessons that I observed in the past as an in-service lecturer in the old curriculum setting. There was little evidence that the curriculum has changed except with regard to seating arrangements and group work. I therefore agree with Rogan (2004) as far as mathematics is concerned. He states that the intended benefits of OBE are hard to find in science classrooms. We conclude from this study that the same is true for mathematics.

Rogan (2004) also asks whether learners were jumping out of the frying pan into another frying pan or into the fire or onto the floor. My opinion is that the learners were definitely not jumping into the fire because in the past the mathematics lessons were also not up to the standard and in the observed lessons teachers did attempt to achieve some of the outcomes in these eleven lessons. They were probably jumping from one pan to another.

*On teaching:*

Hiebert (1999) puts the blame of poor learner outcomes directly on the teachers. According to him, the reason is simple, though under-appreciated – poor teaching. I have also observed poor teaching in some of the lessons, resulting in poor outcomes. Poor teaching could definitely be the reason for not achieving the outcomes mentioned in Curriculum 2005. Based on observations I come to the conclusion that many of these teachers come to their classes without proper preparation. Another concern is that not a single teacher mentioned at the beginning of the lesson any specific outcome that they were going to attempt. I agree with the statement by Hiebert (1999) that the standards proposed by the NCTM are, in many ways, more ambitious than those of traditional mathematics programmes, and this study suggests that the OBE system is perhaps too ambitious for the teachers whose lessons were observed.

*On teaching materials:*

In the past textbooks were used as teaching material. But in these eleven lessons no particular textbook was used by the learners in the class. In addition, in the geometry lessons no mathematical instruments were available. Some teachers used worksheets but did not use it in a way that contributed to achieving the outcomes. Most educators used only chalk and a duster. No new technology or any teaching material from the surrounding environment was brought in. Battista (1999) criticises the standard of the materials used in USA. Perhaps the problem in South Africa is even bigger. There is a lack of sufficient teaching materials for the teachers whose lessons were observed.

*On learners' attitudes:*

Lubienski (2000), in a study done in the USA, notes that in his own teaching, working-class learners are less confident and successful than middle-class learners. He further states that the reform-orientated approaches to mathematics may not enhance the achievement of all learners, as reformers originally hoped and claimed. In the observed situation learners mainly come from a working-class background. Furthermore the OBE is a more reform-orientated approach. In the observed lessons Lubiensky's findings also seems to hold. Many learners appeared to avoid active participation because their more confident peers dominated the participation. In most of the classes the learners answered to the teacher's questions in chorus. Not in any of the lessons did the teachers encourage the quieter learners to contribute.

Learners found it difficult to justify their answers. Not knowing the reasons for their answers was against the basic principle of OBE. My study contradicts the finding done by Riordan and Noyce (2001). Their study in USA showed that standards-based mathematics programmes have a positive impact on learner achievement. I did not find any evidence of positive impact on learner achievement in these lessons.

*On implementation of OBE:*

Reasons for not achieving the outcomes were found to be poor teaching, poor teaching materials and a lack of resources. We conclude that the problem does not lie with the new curriculum but with the implementation. If the curriculum was implemented properly with proper teacher training and with resources available the situation might have been very different. Verspoor (1989) points out that large-scale programmes tend to emphasise adoption and neglect implementation. This seems to be exactly the problem in South Africa.

Rowe (1994) views OBE as a practical way of organising a school poised to achieve improved performance both in the organisation as a system and the people within it that thus enhance quality. In the South African situation there seems to be very little evidence in the observed schools of enhanced quality because of implementing the OBE system.

Treloar (2002) describes OBE as a form of education that makes the goals or objectives of a course explicitly clear. Learners should be informed to what they should understand and be able to do at the exit level and during the intervening stages. Contrary to Treloar's description, making objectives explicitly clear did not happen in the observed classrooms and most likely contributed to the lack of success.

King and Evans (1991) mention in their study that outcomes-based education seems to provide a ready answer to the question of what can be done to reshape America's schools for the 21st century. The government shares this view in South Africa but from my findings there is serious doubt unless we improve our teaching and teaching materials and implementation in general.

Donnelly (2002) mentions that curriculum designers argue that education authorities in Asia, for instance in Hong Kong and Singapore, are, despite their successful systems, so impressed by the New Zealand education system that they are abandoning the approaches in their own syllabi in favour of OBE**.** This is the general idea in South Africa as well but with the way it is implemented doubt is cast on abandoning the old system.

My findings agree with Jansen (1998) that under present circumstances OBE cannot succeed in South Africa unless we improve the teachers' content knowledge, teaching materials and resources.

## 6.4 Recommendations

Based on the analysis of the findings and the conclusions drawn, and with my experience as a mathematics educator and teacher trainer, I wish to make the following recommendations if learning outcomes in the future are to be achieved:

- Mathematics educators need to be thoroughly trained both in content and pedagogical knowledge and need further training to select the content suitable for the learners.
- Teaching material need to be made available. Alternatively, educators need to be trained to prepare their own relevant teaching materials. They need to be trained to use computers to prepare proper worksheets. All schools need to be connected to electricity.
- During the training the different specific outcomes and ways of achieving them need to be thoroughly explained.
- Educators have to prepare for the lessons thoroughly.
- Educators have to provide the skills and knowledge as a basis in all specific outcomes.
- Educators have to attend leadership-training workshops.
- The Department of Education need to provide enough equipment such as tables and chairs to all schools to offer a better chance of success in education.

## 6.5 Issues for further research

In terms of further research it is recommended to look into how and at what level the mathematics learning outcomes as laid down in Curriculum 2005 are achieved, not only in the former Department of Education training schools but also in former model C schools and in independent schools. Such an overview will present a clearer picture of how and how well the mathematics learning outcomes are achieved. It may also provide the answer as to whether OBE divides the society in rich and poor.

The achievement of outcomes is not only measured by observing lessons in the classroom. It deals with other aspects, too, such as assessment of learners. This study did not deal with these. It is recommended that these other aspects, and other kinds of data collection, are included in further studies that focus on the achievement of learning outcomes.

**6.6 Limitations of the study**

During the period that this research was conducted, I was employed as a full-time lecturer in computer programming at a higher education institution. Thus, I interpreted the study with my past experience in OBE and this study was done with only eleven lessons. These factors might entail that I may have been biased in my interpretations and findings.

**6.7 Conclusion of the chapter**

In this study main questions were answered in detail and conclusions drawn. The limitations during the study were mentioned above but they did not in anyway influence the aim and outcome of the study. Issues for the further research were mentioned to help the future researchers in related topics.

**BIBLIOGRAPHY**


Acharya, C. (2003). Outcome-based education (OBE): A new paradigm for learning, *CDT Link, 7 (3)*, 2003

ARC Center Tri-State Student Achievement Study (2000). Study of reform mathematics programs Retrieved on 10 November 2003 from http://www.comap.com/elementary/projects/arc/

Barcan, A. (2001). Education: New assessment can mean almost anything. *News Weekly, Issue: 24.* Retrieved on 12 May 2003 from http://www.newsweekly.com.au/articles/2001mar24_education.html

Barwell, R. (2000). Mathematics teaching in Pakistan and the UK. *Mathematics Teaching, 170*: 36-39.

Battista, M.T. (1999). Fifth graders' enumeration of cubes in 3D arrays: Conceptual progress in an inquiry-based classroom. *Journal for Research in Mathematics Education,30(4)*: 417-448.

Benezet, L.P. (1935). The teaching of arithmetic I & II: The story of an experiment. *Journal of the National Education Association, 24*: 241-244, 301-303.

Botha, R.J. (2002). Outcomes-based education and educational reform in SouthAfrica. *International Journal of Leadership in Education, 5(4)*: 361-371.

Brady, L. (1995). A case study of implementing curriculum outcomes. Retrieved on 28 November 2003 from http://www.aare.edu.au/95pap/bradl95.027

Brownell, W. A., & Chazal, C.B. (1935). The effects of premature drill in third-grade arithmetic. *Journal of Educational Research. 29*, 17-28.

Cohen, L., Manion, L., & Morrison, K. (2003). *Research methods in education.* London (UK): Routledge Falmer.

Cooper, J.L. (1995). Cooperative learning and critical thinking. *Teaching of Psychology. 22*: 7-9.

Croll, P. (1986). *Systematic classroom observations*. London: The Falmer Press.

Department of Education (1997). *Curriculum 2005*. Retrieved on 28 November 2003 from http://www.policy.org.za/govdocs/misc/curr2005.html

Department of Education, Gauteng Province. Retrieved on 28 November 2003 from http://education .pwv.gov.za

Department of Education (1995). *White Paper on Education and Training*. Retrieved on 5 September 2001 from http://www.polity.org.za/html/govdocs/whitepapers/educ1.html

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archieves, 8(1)*. Retrieved on 20 January 2001 from http://epaa.asu.edu/epaa/v8n1

Donnelly K. (2002). Outcomes-based curriculum fails international comparisons. *New Zealand Education Review.* October, 2002. Retrieved on 15 February 2004 from http://www.educationforum.org.nz/documents/articles/

Education Commission of the States (1995). *Outcomes-based education: An overview,* Retrieved on 11 October 2006 from http://www.ncrel.org/sdrs/areas/issues/envrnmnt/go/go4outcm.htm

Faculty of Development Services, University of Pittsburgh (2003). *Classroom observation.* Retrieved on 24 November 2003 from http://www.pitt.edu/~ciddeweb/FACUTY-DEVELOPMENT/FDS/fss6c.html

Fraser, B.J. (1998). Science learning environments: Assessment, effects and determinants. In Fraser, B.J., & Tobin, K.G.(Eds.), *International Handbook of Science Education* (pp.527-564). UK: Kluwer Academic Publishers.

Gay, L.R. (1987). *Educational research, competencies for analysis and application.* America: Merrill Publishing Company.

Geddert, P. (1993). Student success through outcome-based education. *Alberta Journal of Educational Research, 39*: 205-215.

Goldsmith, L.T., Mark, J., & Kantrov, I. (1998). *Choosing a standards-based mathematics curriculum.* Newton, MA:Education Development Center.

Grouws, D., & Schultz, K. (1996). Mathematics teacher education. In T. Buttery, J. Sikula, E. Guyton (Eds.), *Handbook of research on teacher education*. New York: Macmillan Publishing Co.

Haberman, M. (1991). The pedagogy of poverty versus good teaching. *Phi Delta Kappa*, *73*: 290-294.

Hawaii State Department of Education (2000). *Hawaii's Implementation of Standards-Based Education.* Retrieved on 23 January 2004 from http://doe.k12.hi.us/staandards/

Hawaii State Performance Standards Review Commission for Effectiveness and the

Implementation of the Performance Standards (2002). *Final Report*. Retrieved on 2 March 2004 from http://www.doe.k12.hi.us/STATE/DOE/minutes.nsf/

Hiebert, J. (1999). Relationships between research and the NTCM standards. *Journal for Research in Mathematics Education,30(1)*: 3-19.

Jansen, J.D. (1998). Curriculum reform in South Africa: A critical analysis of outcomes-based education. *Cambridge Journal of Education, 28(3)*: 321-331.

Jacobs, M., Gave, N. & Vikalisa, N. (2000). *Teaching-learning dynamics: A participation approach to OBE.* Johannesburg: Heinemann.

Kahle, J.B., Meece, J. & Scantlebury, K. (2000). Urban African-American middle school science students: Does Standards-Based teaching make a difference? *Journal of Reasearch in Science Teaching, 37(9),* 1019-1041.

King, J.A. , Bosma, J. & Bingo, J. (1992). *After two Years: A study of educational transformation in ten Minnesota sites.* Paper presented at a annual meeting of the American Educational Research Association, San Francisco.

King, J.A. & Evans, K. M. (1991). Can we achieve outcome-based education? *Educational Leadership,* October, 1991.

Lampert, M. (2001). *Teaching problems and the problems of teaching.* New Haven CT: Yale University Press.

Lappan, G. (1999). Revitalizing and refocusing our efforts. *Journal for Research in Mathematics Education, 30*: 68-78.

Lofland, J. & Lofland, L. (1984). *Analysing social settings. A guide to qualitative observations and analysis.* 2nd ed. California: Wadsworth Publishing Co.

Lubienski, S. (2000). A clash of social class cultures? Students' experiences in a discussion-intensive seventh-grade mathematics classroom. *The Elementary School Journal, 100,* 377-403.

Mack, N. K. (1990). Learning fractions with understanding of rational numbers: Building on informal Knowledge. *Journal for Research in Mathematics Education, 21,* 16-32.

Mason, L. (1998). Fieldwork education: Collaborative group learning in community settings. *Australian Occupational Therapy Journal, 45*: 124-130.

Mbano, N. (2002). Verbal interactions in CASE lessons in Malawi. *African Journal of Research in SMT Education, 6*: 83-94.

Merriam, S.B. (1988). *Case study research in education. A qualitative approach.* California: Jossey-Bass.

Mokros, J. (2002). Standards-Based Mathematics Curricula: What are they? What Do Students Learn edited by Senk Sharon L. & Thompson Denisse R. Retrieved on 23 November 2003 from http://www.terc.edu/handsonIssues/f02/math.html

Mulder, J.C. (1986). *Statistical techniques in education.* Pretoria, South Africa: HAUM Tertiary Publishers.

Muller, J. (1998). The well-tempered learner: Self-regulation, pedagogical models and teacher education policy. *Comparative Education, 34(2)*: 177-194.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, V.A: Author NCTM.

National Council of Teachers of Mathematics. (1991). *Professional standards of teaching* *mathematics.* Reston, V.A: Author NCTM.

National Council of Teachers of Mathematics. (1995). *Assessment standards for school mathematics.* Reston, V.A: Author NCTM.

National Council of Teachers of Mathematics. (2000). *Principals and standards for school mathematics.* Reston, V.A: Author NCTM.

Page, C. & Meyer, D. (2000). *Applied research design for business and management.* Australia: McGraw-Hill Book Company.

Plato Editorial (2005). OBE: A reality check, *Plato, Newsletter #7,* August 2005. Retrieved on 11 October 2006 from http://www.platowa.com/documents/old/newsletter7.doc.

Riordan, J.E. & Noyce, P. E. (2001). The impact of two Standards-based mathematics curricula on student achievement in Massachusetts. *Journal for Research in Mathematics Education, 32(4)*: 368-398.

Rogan, J.M.  (2004). Out of the frying pan …?: Case studies of the implementation of Curriculum 2005 in some science classrooms. *African Journal of Research in Mathematics, Science and Technology Education, 8(2)*: 165-179.

Rowe, A. (1994). *Quality and Outcome-Based Education,* Canberra, Australia : Niche Multimedia Pty limited..

Reys, R., Reys, B., Lapan, R., Holliday, G. &  Wasman, C. (2001). Assessing the impact of standards-based middle grades mathematics curriculum materials on student achievement. *Journal for Research in Mathematics Education, 34(1)*: 74-95.

Spady, W. (1994). *Outcomes-based education: Critical issues and answers,* The American Association of School Administrators, USA.

Towers, J.M. (1996). An elementary school principal's experience with implementing an outcome-based curriculum. *Catalyst for Change, 25*: 19–23.

Treloar, D. (2002). *Outcomes-Based Education and standards for the University of Western Australia.* http://www.catl.uwa.edu.au/obe/OBE-Discussion.doc.
Retrieved on 16 March 2003 from
http://www.murdoch.edu.au/elaw/issues/v9n3/jones93_text.html

Verspoor, A. (1989). *Pathways to change. Improving the quality of education in developing countries.* Washington D. C.: The World Bank.

Wearne, D. & Hiebert, J. (1988). A cognitive approach to meaningful mathematics instruction: Testing a local theory using decimal numbers. *Journal for Research in Mathematics Education, 19*: 371-384.

Wikipedia, the free encyclopedia, *Outcomes-based education,* Retrieved on 11 October 2006 from http://en.wikipedia.org/wiki/Outcome-based_education.

# APPENDIX A

**The Mathematics Video Lesson Observation Schedule.**

LESSON OBSERVATION SHEET 1

**School:**

**Lesson No:** **Date:**

**Topic:**

**Grade:** **Teacher:**

| Time(min) | Teachers action | Learners Action | Specific Outcomes | |
|---|---|---|---|---|
| | | | input | outcome |
| | | | | |
| | | | | |
| | | | | |

# APPENDIX B

| LESSON OBSERVATION SHEET 2 |
|---|

| | | | |
|---|---|---|---|
| Lesson No | | | |
| Facilitator's Gender | Male | Female | |
| No. of learners | Total | Male | Female |
| Grade | 8 | 9 | |
| Topic/Unit | Algebra | Geometry | |
| Topic | | | |

| | Facilitator's | | Learner's | |
|---|---|---|---|---|
| Specific Outcome | Input Time | T. Method | Achieved | Output Time |
| | | | Y/N | |
| SO1 | | | | |
| SO2 | | | | |
| SO3 | | | | |
| SO4 | | | | |
| SO5 | | | | |
| SO6 | | | | |
| SO7 | | | | |
| SO8 | | | | |
| SO9 | | | | |
| SO10 | | | | |

## APPENDIX C

TABLE 1:

SPECIFIC OUTCOME: NUMBER

| Lesson No. | Total class Time in minutes | Input Time in minutes | Outcome time in minutes | Total input and outcome time in minutes | Input time as a percentage of class time | Outcome time as a percentage of class time | Total input and outcome time as a percentage of class time |
|---|---|---|---|---|---|---|---|
| 1 | 60 | | | | | | |
| 2 | 50 | | | | | | |
| 3 | 48 | | | | | | |
| 4 | 49 | | | | | | |
| 5 | 45 | | | | | | |
| 6 | 45 | | | | | | |
| 7 | 60 | | | | | | |
| 8 | 45 | | | | | | |
| 9 | 45 | | | | | | |
| 10 | 35 | | | | | | |
| 11 | 38 | | | | | | |

# APPENDIX D

Summary of the time spent on inputs and outcomes in all eleven lessons.

| Specific outcome | Number of lessons in which SO occurred* | Total amount of inputs time in minutes | Total amount of outcomes time in minutes | Total amount of inputs time as a percentage of total class time | Total amount of outcomes time as a percentage of total class time | Total amount of SO time as a percentage of total class time |
|---|---|---|---|---|---|---|
| SO1 | | | | | | |
| SO2 | | | | | | |
| SO3 | | | | | | |
| SO4 | | | | | | |
| SO5 | | | | | | |
| SO6 | | | | | | |
| SO7 | | | | | | |
| SO7 | | | | | | |
| SO8 | | | | | | |
| SO9 | | | | | | |
| SO10 | | | | | | |
| Time spent on other than the outcomes. | | | | | | |
| Total | | | | | | |

- Total number of lessons will not add up to 11 since more than one outcome can be addressed in a given lesson.