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A CASE STUDY INVESTIGATION OF HOW ASSESSMENT PRACTICES CONSTRUCT TEACHERS' AND PUPILS' VIEWS OF MATHEMATICS.

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DISCLAIMER STATEMENT

I, Peter Steven Cilliers, hereby declare that the work contained in this minor dissertation is my own work, that it has not been submitted to any other institution previously for assessment purposes, and that all sources, references and peer, tutor and other assistance have been acknowledged.

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Abstract

Assessment practices are an integral part of schooling. The prominence of assessment within schooling in providing information to students and teachers about students' "ability" in learning school subjects, raises an important question: what sort of influence do assessment practices have on how school subjects are perceived by students and teachers? This dissertation focuses on two themes - the way in which assessment practices construct school mathematics, and the way in which these constructions of school mathematics work dynamically with assessment practices to produce descriptions of students. The empirical work for this dissertation took the form of a case-study in which four pupils and one teacher from a model C school in the Southern Suburbs of Cape Town were interviewed. The interviews were loosely structured around questions concerning the pupils' and teachers' views of school mathematics and assessment. The interviews focused on a recent examination paper which the teacher had set and which the pupils had written. The interviews were transcribed and then analysed according to a theoretical framework which was developed by drawing on the work of Bernstein (1975,1990,1993) and Foucault (1982). The analysis generated the following conclusion: that assessment practices produce particular utterances by pupils and teachers about school mathematics, about learners and about the learning of school mathematics. Three dominant notions of school mathematics are evident in the transcriptions. These are that:

1. Mathematics is fragmentary
2. Mathematics is hierarchical
3. Mathematics is about learning and recognising rules.

The construction of the mathematics learner, as made evident in the utterances of the students and the teacher, is predicated on these three notions of school mathematics.

Mathematics students describe themselves and are described by teachers in terms of these three dominant notions of school mathematics. It is assessment which effects these descriptions and assessment which produce these notions of school mathematics. The role that assessment plays both in describing students and in producing and maintaining a particular view of school mathematics I have termed "the organising potential" of assessment practices. This organising potential refers both to the capacity that assessment practices have of providing a particular descriptive structure which divides and names students, and to the capacity of producing particular notions of school mathematics. Assessment practices, this paper argues, construct teachers' and pupils' views of school mathematics and make possible particular descriptions of mathematics students based on these constructions.

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CHAPTER 1
INTRODUCTION

Assessment plays a major role in South African schools. The frequency of testing in the mathematics classroom and the importance attached to examinations and standardised tests bear testimony to this. Furthermore, the grades a pupil obtains at school for mathematics are often a major factor influencing higher academic career, and the opportunities that are either available or unavailable to the pupil following the completion of schooling.

Assessment at school has been an area of major reform in the 1980s and the 1990s, with the emphasis on constructing either more accurate means of assessment, or developing alternative forms of assessment in order to encourage higher-order thinking. These attempts at reform have been driven by the need for more 'accurate' forms of description of students' ability for the purposes of future promotion and selection, and to provide feedback to both parents and pupils. Futhermore, the development of critical thinking is a crucial part of mathematics learning and different forms of assessment are required to support this.

The central role that assessment plays in providing the means for describing students' abilities cannot be denied, but what influence does it have on developing particular constructions of mathematics by both teachers and pupils? And how do these specific constructions of mathematics work together with assessment practices to provide descriptions of students?

The focus of this discussion centres around two issues. Within the context of a small-scale case-study it examines, on the one hand, how assessment practices construct particular views of mathematics. On the other hand it discusses how assessment practices produce descriptions of students both in relation to mathematics and in relation to one another.

The paper is structured in the following way. In Chapter Two I discuss some of the literature on assessment and research into assessment, and argue that literature in this field can be described as being grounded within one of two paradigms. In the first instance, there exists an area of literature which is underpinned by a scientific or conventional paradigm. This literature, I would argue, fails to question critically the affects of assessment and is intent on the more technical aspects of assessment namely, the development of more accurate forms of assessment. In the second instance, my literature survey identifies an area of literature which can be described as falling within a critical paradigm, and which questions the affects of assessment on constructions of views of mathematics.

Although there seems to be a great deal of literature highlighting research into the more technical aspects of assessment, and particularly the achievement of more "accurate" forms of assessment, there seems to be very little research into how assessment practices might affect teachers' and pupils' constructions of mathematics. This paper is intended as a modest contribution to this area of research.

In the Chapter Three I discuss the methodology utilised in this small-scale investigation and discuss the advantages and disadvantages of the case-study method in doing research. The case-study approach was chosen as appropriate for the purposes of this paper, namely to explore particular theoretical assumptions within a single setting.

In Chapter Four I discuss the theoretical framework informing this paper. I draw on the work of Bernstein

(1975,1990,1993) and Foucault (1982) in describing how assessment practices maintain a particular organisation of school subjects, in particular mathematics, and how this organisation generates descriptions of students.

In Chapter Five I provide an analysis of data produced from three interviews that I conducted with a teacher and four pupils. These interviews were transcribed and the transcriptions form the basis of my analysis. My focus is on how the utterances of both the teacher and the pupils construct a particular view of mathematics, and I attempt to argue that this construction regulates the descriptions that students have of themselves, and that the teacher has of them.

Assessment practices, as was mentioned at the start of this introduction, form an important part of schooling in South Africa. What is of interest to this paper is how assessment practices construct pupils and teachers views of mathematics, and it is to this discussion that I now want to turn.

CHAPTER 2
LITERATURE SURVEY

This literature survey serves three purposes:

1. To determine the main thrust of educational research into assessment over the last several years.
2. To establish what the literature identifies as the main issues and debates around assessment, and to examine what it says about the role that assessment plays in school.
3. To establish whether any research has been conducted into how assessment practices construct teachers' and pupils' perceptions of mathematics.

Due to the limitations of a study of this kind, the literature represented in this chapter is not comprehensive, but is rather a sample of the literature that I regard as both important within the field of assessment, and relevant to my own research.

This chapter is divided into two main sections. In the first section a brief description is given of the methods that were employed to sample the literature within the area of empirical educational research around assessment and assessment practices. In the second section I consider in more detail the studies chosen for the survey. Within this section, I focus on work that is concerned with perfecting instruments of assessment, and then on work that is concerned to develop alternative forms of assessment.

SELECTION OF LITERATURE FOR THE SURVEY

Within the area of educational research into assessment, I limited my survey to journal articles or papers that have been written in the last ten years. My survey centred around four educational journals:

1. Journal for Research into Mathematics Education.
2. For the Learning of Mathematics
3. Educational Studies in Mathematics
4. Journal of South African Education

although other journals such as The Mathematics Teacher, Mathematics Teaching, The Cambridge Journal of Education and The British Journal of Curriculum and Assessment were also included in my survey. In addition I reviewed a list provided by the British Educational Index of research papers written in the last ten years, that were grouped in either of the categories of examination or evaluation. I also conducted a search on ERIC using the key-words: educational research; assessment; subjectivity; testing; test items; test content; examination; evaluation; and mathematics. This search revealed forty-two items concerned with or related to mathematics assessment.

The Cockcroft report, the NEPI document, and the SAARMSE Conference proceedings were also explored for material relevant to this paper within the field of assessment and evaluation.

My survey also covered a number of articles which, although informative, were not directly relevant to this paper. These articles touched on issues of assessment and included criticisms of the British National Curriculum (Goldstein (1990); Kuchemann (1990)); a discussion of hierarchies in mathematics education (Hart (1981); O'Reilly (1990)); the stereotyping of abilities in mathematics (Ruthven (1987)); and discussion on how to assess mathematical attainment (Rowntree (1987)).

ASSESSMENT

Within the literature, the terms assessment and evaluation are used interchangeably. In order to clarify what I mean by assessment I will draw on the definition provided by Niss (1993) as a starting point in discussing this issue. Assessment in mathematics, he states,

> is taken to concern the judging of the mathematical capability, performance, and achievement - all three notions taken in their broadest sense - of students whether as individuals or in groups, with the notion of student ranging from Kindergarten pupils to Ph.D. students (p3).

Two issues need to be raised in connection with the above definition. The first concerns the practice of "judging" as an component of assessment. In order to judge "mathematical capability, performance and achievement", some form of evaluation must necessarily be involved. Evaluation, in this sense, is the interpretation of grades achieved for a test or examination as representing "capability, performance and achievement". Assessment therefore encompasses evaluation as a form of "judgement".

The second issue which is highlighted in the above definition is that assessment describes students in a particular way. The purpose of assessment, I want to suggest somewhat polemically, is just that - to describe students in a particular way, highlighting their own individuality and separating them from each other. As Foucault (1977) comments:

> The examination combines the techniques of an observing hierarchy and those of a normalising judgement. It is a normalising gaze, a surveillance that makes it possible to qualify, to classify, and to punish. It establishes over individuals a visibility through which one differentiates them and judges them (p197).

Foucault suggests that assessment separates and describes students by making it possible to measure differences, to determine standards and "to fix specialities" (p197). By judging students' mathematical capability, performance, and achievement, assessment provides what, in Foucauldian terms, constitutes a "normalizing gaze". It is in describing students in terms of some accepted norm, a fixed speciality, that assessment operates to normalise students.

Although Niss (1993) suggests that assessment also involves the judging of groups, the notion of assessment as used in this paper and, I would argue, as used within schools, is to judge students as individuals. The focus on the individual is evident in the two types of assessment that are currently dominant, namely, criterion-referenced assessment and norm-referenced assessment. The former refers to a situation where a student is judged against specific criteria which are explicit and achievable, and is evaluated and described in terms of whether he or she has met these criteria. Norm-referenced assessment occurs when a pupil is evaluated and described with reference to the achievements of other students in his/her class or standard.

In terms of my own research, I define assessment within mathematics as those practices involved in awarding marks or grades, and the use of these marks in order to judge and describe the individual student in terms of some accepted norm.

PARADIGMS AND ASSESSMENT

Assessment, since it encompasses evaluation, involves value judgements. Value judgements are based on a set of assumptions or beliefs which guide and direct activity. In the Kuhnian sense this is identified as a paradigm. What possible frameworks exist within which mathematics assessment operates? Galbraith (1993) comments:

> The way in which we develop assessment procedures... depends crucially on our underlying belief systems about mathematics and what is involved in "knowing" mathematics (p75).

Galbraith locates issues surrounding mathematics assessment within three paradigms. These paradigms are:

1. The Conventional/ Scientific paradigm
2. The Constructivist paradigm
3. The Critical paradigm

I will first draw on the summary that Galbraith provides in discussing the essential components of each paradigm before turning to a discussion of how it informs the literature survey that I conducted.

<u>The Conventional/Scientific Paradigm.</u>

The major assumption characterising this paradigm is that there exists in the world a single reality. This reality is possible to observe and it exists independently of the value system of the observer. By eliminating or controlling any variables which could influence inquiry it is possible to arrive at truth and explain, predict or control nature as it is. Problem solutions have widespread applicability across contexts and across time as generalisations.

Two important consequences for assessment practices flow from this paradigm, in terms of what mathematics is and how competency in mathematics is measured. Operating within this paradigm would mean that characteristics such as mathematical capability, performance and achievement exist unproblematically as a reality, and that these characteristics can be observed and measured in students. The nature of mathematics, what counts as mathematics, what form it takes, and competence in studying it, can all be objectively defined and measured.

The Constructivist Paradigm.

Within this paradigm, there are a number of socially-constructed realities. "Truth" is the best possible construction arrived at through consensus. Facts have no meaning outside of a framework, and facts and values are interdependent. Inquiry is problematic as it consists of humanly-devised ways to make constructions about situations, and these continually undergo some form of refinement. Problem solutions have applicability only within a localised context and have no meaning outside of this context.

Again, the consequences of this paradigm effect mathematics and how it can be measured in a very particular way. Mathematical capability, performance, and achievement, exist as socially-constructed ideas and these characteristics can be observed and measured in students through tests and examinations which have been constructed by consensus. Although these are constantly undergoing refinement, these means of assessment are, by agreement, constructed in this way. The instruments used to measure different components of mathematical ability deliver results and descriptions which only have meaning within a particular framework. In Foucault's (1977) terms these could be described as establishing a "normalizing" practice.

The Critical Paradigm.

The critical paradigm resonates somewhat with the constructivist paradigm in that it rejects the notion underpinning the scientific paradigm, namely, that there is a social reality that exists and that can be measured. However, critical theorists believe that the framework within which the constructivists work, needs itself to be interrogated. The assumption underpinning the critical paradigm is that the frameworks used to interpret the world are themselves "subject to illusory beliefs and irrational influences" (Galbraith,1993:76).

Working within this framework requires that assumptions, belief systems and conditions need to be interrogated and questioned. "The critical approach would address the integrity of the examining and certification system as such, with the view to transforming it" (Galbraith,1993:76).

The location of issues surrounding assessment within a particular paradigm underpins Dowling's (1990) critique of the British National Curriculum and its atomisation of school mathematics into 296 statements of attainment. He suggests that issues in mathematics and assessment can be argued and interpreted from one of two positions: from a position of authority or from a position of critique. He describes these as "the voice authority" and "the voice of critique" respectively. It could be argued that the voice of authority is located within the conventional/scientific paradigm while the voice of critique is located within the critical paradigm. The location of two positions within which discourse surrounding assessment can be positioned is also highlighted by a comment made by Nuttall (1986) concerning educational research. He states:

> ... research has usually been of the technical kind, investigating the efficiency of tests as measuring instruments and as predictors of future success; until recently, relatively little research had been carried out on their social, psychological and educational effects, but such as has been done aligns with the mood of the times to question many of the forms and functions of assessment in education (p2).

The discussion which follows will position the literature surrounding assessment and assessment practices as representative of one of these two voices and attempt to answer the following two questions:

1. What does each voice say about assessment?
2. What is each voice concerned with?

I will look at each in turn.

THE VOICE OF AUTHORITY

The literature grouped under this heading is concerned with two main issues in assessment. These are, on the one hand, refining instruments of assessment and on the other, developing alternative forms of assessment. The focus of the literature in this category is on the ways and means of making tests more reliable, more valid and more able to develop specific competencies in mathematics.

Refining Instrument of Assessment.

What underpins the call for instruments of assessment to be refined is the assumption that assessment at school plays a central role in both providing information about the students capabilities, and as a predictor of success. More refined instruments, advocates of this position would argue, would provide more meaningful results and hence more accurate descriptions of the student to both teachers, parents and students on the one hand, and future employers on the other. The concern is a technical one. The objective is to describe students more accurately, and therefore what is needed is more accurate means with which to describe them.

The refining of assessment instruments is concentrated within three specific areas. These areas are

i. The interpretation of tests scores
ii. The reliability of tests and
iii. The validity of tests.

The Interpretation of Test Scores

The interpretation of test scores is concerned with the question of how meaningful the results from a test are in conveying information about the individual student with respect to his/her mathematical ability. This forms the focus of a paper that Tittle (1986) presented to the American Educational Research Association. This question developed out of a national concern for competency, particularly in mathematics and science, at the level of basic skills. The problem that Tittle addresses is the extent to which test scores reveal anything about the ability or competency of students in mathematics.

The need for a more accurate means of recording students' abilities is also a question that the development of a National Curriculum in Great Britain sought to address. The establishment of different attainment targets was offered as a solution, although this has subsequently been subjected to a great deal of criticism (see Dowling and Noss (1990)). Dowling (1990) sees this development as representing a particular form of mathematics. As he comments:

> ...because the mathematics curriculum is defined in terms of attainments, mathematics itself is being understood as a body of things that people can do (p39).

Dowling draws attention to how the need for more accurate means of recording students abilities is affecting how mathematics is being understood. He comments later:

> ...the voice of authority produces a reading of school mathematics as atomisable into (at least) 296 behavioural objectives, which can be divided into 14 themes and hierarchically grouped into 10 levels within each theme and broadly equivalent across themes (p41).

Even in South Africa, the need for a more accurate means of recording students abilities was raised by Joffe (undated)[1] in her report on assessment for the Education Policy Unit. She comments:

> With the ever-increasing changes in work practices to accommodate new technology, employers and selectors for further training are finding that there is a need for more broadly-based evaluation procedures, that provide information beyond a written test score (p8).

More refined assessment instruments are needed to provide more 'accurate information' about the individual student. However, as educationalists and in particular as mathematics educators, we need to ask if, and how, the need for more accurate results is producing a particular understanding of mathematics. We need to question, as Dowling (1990) does above, what sort of reading this endeavour is producing of mathematics.

Although Joffe (ibid) highlights just one aspect of the usefulness of results - in this case for the future employees or for selection - there are clearly two other aspects of tests scores which are also important. In what sense are the scores meaningful for the student, in order to facilitate self direction, and in what sense are the test scores meaningful for the teacher for instructional planning? In all three instances, whether tests provide information to the student, teacher or future employer, the accuracy of tests in assessing certain objectives remains important. This accuracy is dependent on the reliability and validity of tests and these two considerations receive a great deal of attention in the literature I surveyed.

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[1] Attempts to contact the author to establish the date of ublication of this article have been unsuccessful.

The Reliability of Tests

Reliability refers to the extent to which the results obtained from a test are consistent: in other words the degree to which the results can be replicated. According to Green (1991) there are four different forms of test reliability. These are stability reliability, which refers to consistency over time, equivalence reliability which refers to the consistency over different test forms, interrated reliability which is consistency across raters or scorers, and internal consistency which is consistency within a single test.

Green identifies three major factors influencing reliability. These are the variability of the tested group in ability or attitude, the difficulty level of the test items and the number of questions in the test. Secondary factors which, Green suggests, could influence the reliability of tests, include item clarity, clarity of instructions and the freedom from distractions.

A number of different means of testing reliability are dealt with in more detail in Sax (1989) and Anastasi (1988) and will not be entered into in this discussion. There are however a number of questions that need to be asked in terms of my own research interest which are related to the factors that Green (1991) identified above as having an influence on the reliability of tests.

Green (1991) argues that test reliability can be influenced by whether or not the tested group is homogenised in terms of ability or attitude. The implication I draw from this is that for tests to be considered reliable, different ability groups need to be separated from one another. The concern with reliability in this case will lead to a hierarchy of ability being developed among the students within a particular subject group. Those who are described as having the "ability" to do mathematics will be separated from those who are described as not having this ability.

Clearly the individual student is of secondary importance when the concern is primarily with the technical aspects of the test. It could be argued that more accurate means of testing will ultimately benefit the student, but in designing more accurate instruments of assessment, are we not simply designing more accurate means of description? Where is the student as subject in the move toward refining instruments of assessment?

The construction of the student is not foregrounded within this approach and one could argue that the concern with reliability ultimately results in a form of streaming, and therefore in a particular form of construction of the student. The question that this paper is concerned with is how this construction of the student, in terms of his/her ability, and the hierarchical arrangement of the student in terms of this description, produces and reproduces a particular reading of mathematics.

Other factors mentioned by Green raise further interesting questions. The categorisation of test items as "difficult" is one such factor which needs further elaboration. How is difficulty measured and from whose point of view are test items described as difficult? What renders some test items difficult and other test items easy? If test item difficulty is regarded as a possible factor influencing reliability, these questions need to be answered. Test item difficulty is a subjective perception which is related to a particular construction of the subject being tested. Pupils constructions of the subject should, as a result, be regarded as vitally important. However, although Romberg (1993) comments: "There is a body of research which sets out to explore pupil constructions about mathematics" (p174), my own survey of the literature proved fruitless in locating studies which focus on how **assessment practices** construct views of mathematics.

Item clarity and clarity of instruction mentioned by Green (1991) as influencing reliability are also two very subjective categories. The work of the Assessment of Performance Unit (APU) under the auspices of the DES, considers the question of item clarity, and it is with reference to this that Goldstein (1990) comments:

> The work of the APU in mathematics... has shown how something as simple as a change in presentation format can change performance markedly (p69).

The concern here remains focused on the technical aspects of assessment. The technical concerns with assessment evident in the literature fail to answer the question that Mellin-Olsen (1993) raises: "Where is the student as subject?", and that serves as the foundation on which my own research is conducted. My concern with how assessment practices construct views of mathematics is not a technical one. I am interested in examining how assessment practices produce particular constructions of mathematics and how these constructions inform descriptions of mathematics students.

The Validity of Tests

At a theoretical level, the validity of tests is discussed by Romberg (1993) and by Ridgeway and Passey (1993) who between them identify nine types of test validity. These nine types of validity (which I am not going to list here) are by no means a comprehensive list of the different forms of test validity that make up the research into this area. In my own research I came across several articles (see Tittle (1989); Romberg et al (1982)) including the two mentioned above that deal with this issue either theoretically or empirically.

The validity of tests refers to the extent to which a 'true judgement' can be made using the test results. The particular form of test validity which raises some interesting questions for my research is Ridgeway and Passey's (1993) identification of a generative validity of tests. This refers to the changes in behaviour which occur as a result of a particular set of measures being used. For example, if a test focuses on skills rather than on conceptual understanding, generative validity will then refer to the extent to which the test changes the skills of the pupils writing the test. Another aspect of the generative validity of test is the unintended consequences of testing programmes and Tittle (1992) discusses this particular aspect as well.

The notion of generative validity raises interesting questions about how the concern for more refined instruments in assessment might lead to change in behaviour of students and their focusing on particular aspects of the test instrument and not on others. Hargreaves (1989) draws attention to this aspect in discussing the consequences of regular assessment which forms part of the school curriculum in the United Kingdom. He suggests:

> Through the use of graded assessment and stepped levels of achievement, horizons are not just shortened, but limited too. Through the use of pupil profiles, process of negotiation and target setting, institutional loyalty and adjustments are secured. Through the development of elaborate, modular, credit-based structures, the system is bureaucratically mystified and made non-accountable to those who use it and whose opportunities are affected by it (p114).

One of the reasons regular assessment was introduced in the school curriculum was to improve pupil motivation. Hoyles (1990) comments:

> Regular assessment is also expected to enhance pupil motivation through mastery of short term goals, and 'knowing where you are and where you are going'(p116).

Assessment, argues Hargreaves (1989), becomes an end in itself. The focus of the school curriculum on the needs of the system, such as pupil motivation, leaves what is learned as unimportant. The question that needs to be asked then is what is learned? What views of mathematics are being developed within the students as we concern ourselves with providing more accurate, more reliable, more valid descriptions of students, in order to cater for the needs of those who are interested in having accurate records of the students' abilities, whether these are teachers, parents or future employers?

Tittle (1992), in considering the question of test validity, suggests an expanded framework which includes both the perspectives of students and teachers, as well that of test makers and scientists. She argues that the development of educational assessment must take place within an understanding of how tests are used in context.

We need to move from a position where we are asking "what are we trying to achieve" to a position where we consider "what is it that we are achieving?" What perceptions do the pupils have of mathematics as a result of the assessment practices that we are currently employing at school? What is the overriding concern with the technical aspects of assessment doing in terms of the construction of the subject of mathematics? That is the question that forms the focus of my own research paper.

Alternative Forms of Assessment

The assumption underpinning alternative forms of assessment is that different forms of assessment support different constructions of mathematics. The move to include different forms of assessment, such as investigations and applications in the mathematics curriculum, is underpinned by the assumption that these different forms of assessment will develop among the pupils notions of mathematics as investigative and applicable in real life situations. This notion is evident in the thinking of the NCTM cited by Joffe (ibid):

> Students should learn that mathematics is more than a collection of concepts and skills to be mastered... demonstration of good reasoning should be rewarded even more than students' ability to find correct answers (p8).

The assumption underpinning alternative forms of assessment is that rewarding the "demonstration of good reasoning" in alternative assessment forms such as investigations and real-life applications, will develop in the students the understanding that mathematics is "more than a collection of concepts and skills to be mastered". It is a notion that this paper is interested in exploring. This assumption, as far as I could establish, is not supported by empirical research. This, it seems, should not be surprising, as it would appear that the influence of assessment within the educational process over a wide range of areas is assumed without the backing of empirical research. Hargreaves (1989) comments:

> Examinations are widely held to be responsible for a number of common ills in the teaching and learning process. It is said that they lead to didactic teaching, cramming, over-emphasis on dictation and written work and to a lack of group work and opportunities for the exercise of individual initiative. Interestingly while the claim is a common one and has reached a status of

> becoming virtually accepted 'fact', supportive evidence in educational research findings is not strong (p149).

Nevertheless, the assumption informing the move toward alternative forms of assessment, is that it is possible to change pupils' understanding of the nature of the subject of mathematics by changing the nature of assessment instruments. The following quote from the NCTM Standards document cited by Joffe (ibid) is evidence of this:

> ...student work is evaluated via pencil-and-paper tests; students thought processes on reasoning are not considered. This fragmentation, the emphasis on pencil-and-paper procedural skills, and the simplistic form of evaluation have effectively separated students from mathematical reality and intellectual growth (p7).

The objective in changing the nature of instruments is to reconcile students with a mathematical "reality" and to cultivate "intellectual growth". It is this objective that informs the drive currently evident in education towards what is termed "alternative" forms of assessment characterised by problem-solving, investigations and groupwork (see Wolf (1990)). These new forms of assessment, it is argued, will develop critical or higher-order thinking. The underlying assumption is that the nature of the instruments used in assessment, develop a particular form of mathematical thinking which, it seems, corresponds more closely to what mathematicians do.

Niss (1993) suggests that higher-order thinking[2] will be developed by items of assessment which:

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[2] See also: Kulm, G. (1990) and Lesh, R. and Lamon, S. J. (1992)

i. are non- algorithmic
ii. are complex, where the path to the solution is not visible
iii. have multiple solutions
iv. involve nuanced judgement
v. have a measure of uncertainty
vi. are self-regulating
vii. impose meaning and
viii. require effort.

Ridgeway (1988) suggests that unless the nature of assessment instruments are changed to include heuristics and methods of proof, problem solving, and modelling, the focus on objects of assessment such as knowledge of mathematical facts, the mastery of standard methods and techniques, and the performance of standard applications will "...contribute to actually creating a distorted and wrong impression of what mathematics really is" (p17).

The influence of assessment practices on the construction of mathematics, while not supported by empirical research, is an assumption that informs the drive toward changing the nature of the instruments for the purpose of tests and examinations. Ridgeway (1988), criticising the dominant position that the task occupies as the main item of assessment, comments:

> One important consequence of the fact that the task constitutes the predominant items of assessment is that the tasks used point out (to the students as well as to the teachers) what the essential components of mathematics and mathematical ability are considered to be (p20).

He comments further : "...assessment tasks filter and mould the perceptions of mathematics as a subject" (p20). This argument supports the move towards changing the nature of assessment instruments in order to develop more critical forms of thinking. However, my attempts at unearthing empirical research which supports this claim have proved fruitless.

"Progressive" approaches such as the one referred to above, although seeking to promote alternative forms of assessment, do not do so with a critical focus. As Gaddis and Volmink (1993) comment:

> Traditional approaches in mathematics education have focused on competency in a very narrow sense. The more progressive approaches have encouraged engagement, but not necessarily with critical focus. Overall, most curriculum practice in mathematics has been aimed at getting students to generate pre-determined ideas with little concern for promoting a critical engagement with mathematics or for looking at mathematics from a critical perspective (p383).

Gaddis and Volmink, it seems to me, are suggesting that alternative forms of assessment, which they refer to as "curriculum practice", are aimed at getting students to reproduce ideas which conform to an accepted idea of what constitutes higher order or "critical" thinking. These forms of assessment need themselves to be criticised.

What does the voice of critique have to say about the influence of assessment on constructions of mathematics? It is to this discussion that I now want to turn.

<u>THE VOICE OF CRITIQUE</u>

I have taken the voice of critique to refer to the critical paradigm which argues that assumptions, belief systems and conditions need to be interrogated and questioned. The objective of this paradigm then, with respect to assessment, is to examine, from a critical perspective, the assumptions, belief systems and conditions which underlie assessment practices with the view to changing them.

Within the literature I surveyed there were several examples of the voice of critique operating to question the assessment practices that currently dominate schooling. The concern is not a technical one, as is the case with the literature in the section above, but instead focuses on how assessment practices lead to particular constructions of mathematics, and particular constructions of the student.

Dowling (1990), in his criticism of the British National Curriculum, states his position quite clearly:

> My voice of critique thus challenges the vision of mathematics as an empiricist activity, as comprising tangible concepts which are to be developed as a sequence of pedagogic encounters, and as fundamentally useful - the vision of the National Curriculum (p50).

It is this conventional vision of mathematics which, argues Dowling, informs the National Curriculum to assess mathematics in terms of 296 statements of attainments divided into 14 themes across 10 levels. This, he argues, presents an understanding of mathematics as a "body of things that people can do" (p39). He suggests that operating within the conventional framework and presenting mathematics as a series of attainment targets as the National Curriculum in Great Britain does, constructs a particular understanding of mathematics. This claim is however, as far as I can establish, not supported by empirical research and is a question that I am setting out to explore. What are students understandings of mathematics? Do they see it simply as a body of things that they can do; as comprising tangible concepts which develop through a sequence of pedagogic encounters? In what way does assessment influence this understanding?

Turner (1983) in a study on what he terms "exam-orientated" pupils, suggests that the hidden curriculum of examinations is made tangible in the development of "instrumentalism" on the part of the pupils where the examination is perceived as the sole purpose of school (p198). This, he argues, results in the pupils setting out to learn "...not the official syllabus, but only what is needed in order to pass the exam" (p197). This suggests that assessment practices construct, amongst "exam-orientated" pupils, a particular strategy with which they can recognise what work is regarded as important for the exam and what is not. This Turner refers to as "question spotting"(p197).

Clearly this is one way in which assessment influences a particular understanding of mathematics. On the other hand, assessment can also influence the format of questions that are included in examinations. This is the focus of study which informs Wolf's (1990) criticisms of the attempts by the British National Curriculum to introduce investigations and 'real life' applications into the curriculum. Wolf argues that investigations and practical tasks are not easy to mark, and that the need to evaluate accurately leads to "dressed up" mathematics problems that, in some instances, have no clear solutions. Applications, Wolf suggests, are on the "retreat" because they require considerable non-mathematical knowledge and call for large volumes of data (p149).

The literature that I surveyed on assessment and assessment practices concentrated on either perfecting instruments of assessment, or on developing alternative forms of assessment. The focus of this paper is not on either of these two aspects. Instead, I am concerned with how assessment practices construct teachers' and pupils' views of mathematics, and at the same time construct learners in relation to each other, and in relation to mathematics. I am suggesting that these two constructions occur dynamically and that each element feeds into the workings of each other.

It is to an analysis of these concepts that I now want to turn.

CHAPTER 3
METHODOLOGY

This chapter is divided into three sections. In the first section I discuss my choice of the case-study approach as a research strategy and consider some of the shortcomings of the case-study approach. In the second section I discuss the context in which the research was carried out, and in the final section I discuss interviewing as my choice of data collection.

CASE-STUDY

Motivation for Case-Study

The case-study approach was chosen because I wanted to explore how assessment practices construct teachers' and pupils' views of mathematics within a restricted situation. Rose (1991) citing Mitchell (1983) explains that Mitchell characterises the case-study approach in terms of "a detailed examination of an event which the analysts believe exhibits the operation of some identified theoretical principle"(p192). A case-study is an empirical enquiry that investigates a contemporary phenomenon within it's real-life context. It is not a representative sample but a deliberate choice of a critical case to see if certain theoretical assumptions can be validated. A case-study can therefore be described as a "snap-shot" approach to research.

There are two issues which need to be dealt with at this stage. These concern the validity and reliability of the case-study approach such as the one that was conducted in the production of this paper. Validity is concerned with whether the study indeed measures what it is intended to measure; reliability with whether the study can be replicated by another researcher in the same context. As Alan (1991) argues:

> the reliability of research does not lie in the purity of the questions asked or the actions followed, but rather in the degree to which others can follow exactly the same procedures (p181).

All the procedures therefore used in this study will be made as explicit as possible in order to facilitate the reliability of my findings. This applies also to the development of categories and the selection of transcript text in my data analysis. In this way I have also attempted to address the issue of validity.

The shortcomings of the case-study approach exist in the fact that findings cannot easily be generalised. However, as will be argued later, case-study research allows for the possibility of the development of theory based on findings produced within a single context. A case-study is not however a sample that can be generalised to a larger universe. As Yin (1984) comments:

> This analogy to samples and universes is incorrect when dealing with case-studies. This is because survey research relies on statistical generalisation, whereas case-studies rely on analytical generalisation (p39).

Analytical generalisation is the attempt to generalise a specific set of results obtained from a single case to a broader theoretical position. Case-studies allow the development of theory. The case-study approach, as it represents the development of a hypothesis within a single situation, affords the possibility of developing a theoretical position. It is not the goal of case-study research to develop a position which, as in the case of survey research, can be generalised statistically to the broader universe. The goal of my research is therefore to develop a theoretical approach within a single event, which might contribute to a broader theoretical understanding.

CONTEXT OF THE STUDY

The school within which the research was conducted was a co-educational model C school in the Southern Suburbs of Cape Town. This particular school was chosen for a number of reasons. Its status as a model C school means that it is expected to adhere to certain guidelines set out by the Department of National Education with reference to the measuring and recording of the academic achievements and progress of pupils. As a result, examinations, standardised tests, and class tests form an integral part of the school's curriculum. The fact that it is a co-educational institution means that both boys and girls could be included in the research that I was conducting, and I could take account of possible gender differences. The school is also located quite close to the University of Cape Town and the choice was therefore also predicated upon practical considerations. Close connections between members of the professional mathematics education community also allowed me relatively easy access to the school.

Interviews were conducted with four pupils and one teacher. The teacher concerned was invited to do so as she had set the particular test around which the discussion in the interviews was to be conducted. She was also the class teacher of the lowest set of standard eight higher grade mathematics students (the idea of "sets" is discussed later.) Initially I had planned to interview two standard eight higher grade mathematics teachers but was informed a few days before I visited the school that this would not be possible. Although the Head of the Mathematics Department did make himself available for discussion following the completion of all three interviews, I felt that I had sufficient data to work with and his offer was not taken up.

The four pupils who were chosen were drawn from the standard eight higher grade mathematics grouping. The mathematics pupils in the senior standards (standards eight, nine and ten) in most model C schools are divided into two groups - a higher grade group and a standard grade group. Each group follows its own syllabus where the standard grade group covers less work in the academic year and disregards certain sections in the mathematics syllabus which the higher grade group would be expected to cover. The distinction between the higher grade and standard groups is similar to the distinction made between groups following the G or Y series texts in the SMP 11 - 16 syllabus in Great Britain.

The separation of pupils into higher grade or standard grade groups takes place on the basis of their standard seven examination marks. The mark required by standard seven pupils to continue onto higher grade in standard eight varies from school to school, but is normally around fifty percent. Pupils can however choose to remain on higher grade in the event of them not achieving the minimal requirement.

The higher grade grouping is divided into four distinct sets each of which is a homogeneous grouping of pupils ranked according to their previous years' marks. The sets are hierarchically ordered and so a distinction can be made between the "top" set and the "bottom" set within the higher grade grouping.

In selecting the four pupils, a boy and a girl were chosen from the top set and a boy and a girl were chosen from the bottom set. The choice of which boy and girl pair participated in the research was negotiated with the individual class teachers according to the following criteria: that the pupils would feel comfortable answering questions in each other's presence and that they were unlikely to feel inhibited in discussing questions with an adult unknown to them.

INTERVIEWS

The semi-structured interviews focused on assessment and mathematics. (See appendix for a more detailed outline of the interview schedule). I had access to the mathematics test which the pupils had recently written, as well as copies both of their individual answer sheets and of the memorandum used by the teachers in marking their scripts. These scripts were used in the construction of an outline of an interview schedule and were also used during the interviews to refer to.

The interviews were conducted during school time in rooms that the school had made available to me. An hour was set aside by the school for each interview and this placed a limit on the amount of time that could be spent interviewing. The first interview with Steven and Jackie took place in the school library and a number of interruptions during the interview had to be dealt with. These interruptions were caused by the presence of other students who were using the library and by teachers who were in charge of these particular students. As a result some of the comments made by Steven and Jackie were not audible when the interview was transcribed. However, the interruptions did not seriously affect the process of the interview. The interview with Deon and Ingrid, and the interview with the teacher Julie, took place in a private room which was unfortunately not available on the first day. As a result no interruptions took place.

The interviews had to take place fairly early on during the second semester so as not to interfere with examinations and preparation for these. No follow-up work in the form of further interviewing was carried out as sufficient data was generated in the planned interviews. It was also not feasible in light of the fact that the school had to accommodate me and follow-up work would lead to the further disruption of students' routine activities.

Methodology Chosen

I chose the interview method for my data collection. The interviews were conducted following a test that the pupils had written, as part of a test series that the school conducted within the third term. The test series consisted of two tests intended to examine the work that had been covered in the third term. The timing of the interviews had to coincide with a number of factors:

1. The availability of both teachers and pupils to participate in the interviews.
2. That the standard eight pupils participating in the interviews would have recently completed a mathematics test.
3. The time constraints placed on my own research due to the fact that I could only proceed with the research following the successful completion of the first part of the masters program which ended in July.
4. The fact that the research could not be conducted before permission had been obtained from the relevant authorities. This involved obtaining permission both from the headmaster of the school and from the Research Section of the Cape Education Department (CED). I had to wait until I had received written confirmation from the CED that my written application to do research had been received and my research topic approved.

The interviews were tape-recorded and the dialogue then transcribed. All three interviews were loosely structured around a particular framework (see Appendix) but this was merely intended as a guideline to ensure that certain topics were covered. Field notes were taken in the second interview but only in the form of questions that I had not originally planned in my interview outline. Interview one also developed ideas in the form of questions which were used in interviews two and three. In both instances these questions have been included in the appendix.

Data Collection

The data was collected over a period of two days using the methodology outlined above. The dialogue was transcribed in full. Aspects of the discussion such as tone, and other phonetic characteristics were not transcribed as this unnecessary for the purposes of my analysis. Pauses, hesitations and interruptions are indicated in the transcription in the form of three dots.

Each interview lasted approximately fifty minutes. A total of two-and-a-half hours of discussion made up the data text for analysis, which formed approximately one hundred typed pages of transcript. The data was then analysed in terms of the theoretical framework which is discussed in the next chapter and it is to this discussion which I now want to turn.

CHAPTER 4
THEORETICAL FRAMEWORK

In developing a theoretical framework I will be drawing on two main sources, namely Basil Bernstein (1975,1990,1993) and Michel Foucault (1982). This theoretical framework is still very much in its infancy, and the purpose of this chapter is to discuss the possibilities of a model which can describe the influence of assessment on school mathematical discourse. Two main themes underpin the discussion in this chapter - how assessment practices organise school mathematics, and how the same practices describe students and construct them as subjects.

RECONTEXTUALISING RULES

Bernstein (1990) suggests that school subjects, of which mathematics is one, are an appropriation from what he terms "the primary context of the production of discourse" (p185). This primary context exists outside the context of the school and is a field in which a particular discourse is generated. For example, mathematics is clearly produced outside the context of the school but can be appropriated into the schooling context and studied as part of the school syllabus as school mathematics. Subjects that constitute the school curriculum are produced largely within the academic domain, and are relocated and refocused to form part of the school curriculum. The principle by which subjects, or what Bernstein describes as discourses, are appropriated from these fields of production, he terms pedagogical discourse. Bernstein comments:

> Pedagogic discourse is a principle for appropriating other discourses and bringing them into a special relation with each other for the purposes of their selective transmission and acquisition (p183,184).

Bernstein argues that pedagogic discourse embeds these "other discourses", which are appropriated from contexts outside of school **within a particular social order** which he describes as "rules of order, relation and identity" (p184). These rules create, in Bernstein's language, a virtual or an imaginary discourse which is then transmitted to and acquired by the students in the school. Bernstein elaborates on the main idea underpinning his argument with the example of school physics. He comments:

> The rules of relation, selection, sequencing, and pacing (the rate of expected acquisition of the sequencing rules) cannot themselves be derived from some logic internal to physics nor from the practices of those who produce physics. The rules of reproduction of physics are social, not logical, facts (p185).

In other words, the way in which subject knowledge is transmitted from teacher to pupil, and then reproduced by the pupil within the schooling context, depends on the social organisation of the school, and not on a logical organisation internal to the subject.

This forms the central idea underpinning my discussion in this chapter. School mathematics is not shaped by a logical organisation internal to the subject. Rather it is structured by "rules of order, relation and identity" (p184) which form the basis of the particular organisational structure in the school. I want to suggest that assessment practices form an integral part of this organisational structure, and sustain particular rules of order, relation and identity. It might be argued that assessment practices do not simply sustain these rules, but in fact produce them. It is not my objective to contribute to this debate and, for the purposes of this paper, it needs to be accepted axiomatically that assessment practices are implicated in the maintenance of order, relation and identity.

Assessment practices, I will argue, allow for a particular description of mathematics students, and this description simultaneously relies on and maintains a particular organisation of school mathematics. The discussion in this chapter focuses on how descriptions of mathematics students, and students' and teachers' views of mathematics, are structured by assessment practices.

ASSESSMENT AS A MESSAGE SYSTEM

Bernstein (1975) identifies assessment as one of three "message systems" through which formal educational knowledge is realised. He comments:

> Formal educational knowledge can be considered to be realised through three message systems: curriculum, pedagogy and evaluation. Curriculum defines what counts as valid knowledge, pedagogy defines what counts as a valid transmission of knowledge, and evaluation defines what counts as a valid realisation of this knowledge on part of the taught (p85).

In describing assessment (or, in his terms, evaluation) as a "message system", Bernstein, it seems to me, is pointing to assessment as a defining element which makes visible to the taught what counts as valid knowledge. In other words, assessment provides a means by which the reproduction and operationalisation of knowledge can be validated. The reproduction and operationalisation of this knowledge has to conform, as was argued earlier, to a particular organisation of, or principle governing pedagogical discourse. Assessment practices sustain the rules of order, relation and identity regulating this organisation by validating the reproduction and operationalisation of knowledge, which in turn conforms to a particular pedagogical discursive framework. Assessment sustains these rules by functioning dynamically with the social organisation of the school and structuring subjects appropriated from the fields of production in particular ways. Assessment, in sustaining these rules, also operates in conjunction with curriculum and pedagogy. While my own research focuses on assessment as an independent entity, I realise that in practice assessment does not function independently. Assessment does however play a central role both in determining what counts as valid knowledge and, as I will argue later, in describing students, and it is for this reason that I have isolated assessment as the focus of my research.

I want to turn now to a discussion of the first theme underlying this chapter, namely how assessment practices organise school mathematics.

THE ORGANISATION OF SCHOOL MATHEMATICS

Bernstein (1975,1991) is interested in describing how power and control are established in pedagogical communication and how this leads to the establishment of a particular consciousness. Fundamental to his analysis are the notions of space and time and he develops his ideas of classification and framing from these. I will discuss my interpretation of Bernstein's use of these two ideas and then elaborate on how I found them difficult to implement in my analysis, and yet productive in generating some thoughts on a possible theoretical framework.

Classification

Classification refers to the relations between contexts, between agents, between discourses, or between practices within the framework of the curriculum. Classification, in Bernstein's terms, determines the WHAT. It does so by maintaining a space, an insulation, between elements such as contexts, agents or discourses. Bernstein uses classification to refer to the **boundary** between groups or contexts or practices. Strong classification means strong insulation while weak classification means weak insulation between contexts.

With regard to mathematics then, classification refers to the boundary between mathematics and other subjects. It refers to the relations between mathematics teachers and other teachers, to the relations between mathematical discourse and non-mathematical discourse, to the relations between mathematical practices and non-mathematical practices.

If a curriculum is strongly classified then subjects are strongly bounded with respect to each. A weakly classified curriculum means that the curriculum is an integrated network of different elements of knowledge. The relations in the first instance are well-defined and clear, while the relations in the latter instance are loosely defined and indistinct.

Framing

While classification refers to the WHAT, framing refers to the HOW. Within the context of the school, framing describes the pedagogical relationship between teacher and taught and refers to the degree of control the teacher and pupil possess over four elements within this pedagogical relationship. These are the

i. selection
ii. organisation
iii. pacing and
iv. sequencing

of the transmission and reception of knowledge. Strong framing within this relationship would mean that the teacher has a high degree of control over these four elements. Weak framing would mean that the student has a high degree of control over at least the last three elements in the list. Due to the nature of the relationship within which the student finds him/herself at school, he/she can rarely have a high degree of control over the selection of the knowledge that is transmitted. Bernstein suggests that it is possible to have strong framing over one element, while at the same time having weak framing over the others.

The Use of Notions of Classification and Framing in Practice

In attempting to apply the notions of classification and framing to my reading of my data, I discovered that it was, in practice, difficult to separate them from one another. It was not clear to me whether I could describe the utterances of the pupils and the teacher I interviewed in terms of classification procedures or in terms of framing procedures. The distinction seemed clear theoretically, but became blurred when trying to analyse utterances by pupils and teachers about mathematics. Clearly, within the schooling context, classification refers to the curriculum, while framing refers to the "principle regulating the communicative relations" (Bernstein,1990:36) between teacher and pupil. However, underpinning both the idea of framing and classification is the notion that both teachers and pupils respectively recognise and reproduce what counts as "valid" knowledge. The question that needs to be asked is: are the rules by which they recognise valid knowledge the result of classification procedures, or the result of framing procedures? The difficulty I had in separating classification and framing developed as a result of my attempts to answer this question. For example, I will argue later that assessment practices punctuate school mathematics between years (for example, between standard seven and standard eight) and within years (for example, topics within standard seven algebra). This suggests a classification of contents, but also its sequencing and pacing (framing). In practice, therefore, it proved difficult to separate the

WHAT and the HOW. Classification and framing appeared to be interchangeable.

The difficulty in trying to separate these two categories from one another, although problematic for me on the one hand, served to illuminate the focus of my research. Bernstein, in developing the notion of classification and framing, is interested in examining the structure of the three message systems, namely curriculum, pedagogy and assessment. My interest lies specifically in examining how the message system of assessment structures or constructs. Bernstein's concept of framing describes the degree of control over such elements as selection, organisation and sequencing of knowledge. For knowledge to be sequenced, however, it has to be separated into different parts which can be sequenced; in other words it has to be fragmentable. The organisation of school knowledge is based on this possibility. Sequencing is predicated on a notion of learning as a set of pedagogical encounters which occur in some linear fashion, and underpinning this is a particular perception of knowledge as fragmentable and hierarchical. My interest lies in trying to describe how the idea of a school subject as fragmentable and hierarchical is developed and maintained.

Framing also focuses on the relationship between teacher and pupil. My analysis takes this relationship into account only sofar as it is implicated with how assessment provides a description of the pupil in relation to school mathematics, and in relation to other learners. I argue that assessment practices convey a message of description of pupils, and that this message is predicated on a particular structuring of school mathematics - a structuring that simultaneously is developed and sustained by assessment practices as it describes and provides a particular form of description for the student.

Bernstein (1975) describes evaluation as defining what counts as a "valid realisation of knowledge on the part of the taught" (p85). He suggests that evaluation appropriates the procedures of classification and framing and that these operate to create a particular evaluative structure. This evaluative structure legitimates the realisation of certain forms of knowledge and therefore serves to maintain either strong or weak classification and framing procedures. The difficulty I had in applying this idea to my own analysis was that the interview transcripts that I was analysing were not what I would describe as the "realisation" of mathematical knowledge. The transcripts reveal instead ways in which students utterances about mathematics convey a particular description of the realisation of this knowledge. I am interested in the form or the structure of mathematics and not the content of the subject. Bernstein attempts to provide a descriptive language of how, through the realisation of a particular knowledge, and the establishment of a particular consciousness, different forms of power and control are realised. My interest lies in trying to explain how through particular descriptions of the student, and the construction of the student as subject, assessment contributes to sustaining a particular understanding of the structure of school mathematical knowledge.

However, despite these differences, Bernstein's notions are productive in providing some ideas on which a possible theoretical model could be constructed.

Regulative and Instructional Discourse

Bernstein (1993) argues that there are two systems of rules that are affected by framing: rules of social order and rules of discursive order. The rules of social order he terms regulative discourse, and the rules of discursive order he terms instructional discourse. Pedagogical discourse, suggests Bernstein, can then be represented in the following way:

$$\text{Pedagogical discourse} = \frac{\text{instructional discourse}}{\text{regulative discourse}}$$

Instructional discourse, in this figure, is represented as being embedded in regulative discourse. It is the regulative discourse that is the dominant discourse. The rules governing the relation, selection, sequencing and pacing of a subject within the pedagogical relationship between teacher and pupil are not inherent within the subject, but have to be created. Bernstein suggests that these rules are social, and that they constitute the regulative discourse within which the instructional discourse is embedded. I want to suggest that the way the subject is constructed is predicated on the organisational structuring of the school of which assessment practices form an important part.

Instructional discourse refers to the competencies, skills and content which are to be transmitted. The regulative discourse Bernstein describes as rules of social order. It is these rules of social order which maintain the positioning of students as students and teachers as teachers, and which underpin the organisational structure of the school. These rules of social order are made explicit and maintained within the context of the school in a number of ways. The arrangement of desks within a classroom, the existence of different classes for different standards, the separation between a work place and a place within which to play, all make explicit and maintain the rules of social order which govern the organisational structure of the school. The regulative discourse includes both discourse between pupils, and discourse that the pupil appropriates from the schooling context to motivate and criticise him/herself. Within each relationship there exists the possibility of description, where the teacher can describe students, students can describe each other, or students can describe themselves.

I would like to suggest that assessment practices also form an integral part of the regulative discourse. While the physical arrangement of desks or classrooms makes explicit and maintains the rules of social order in one particular way, assessment practices maintain and make explicit the same rules by providing descriptions of students that conform to a particular organisation or principle governing pedagogical discourse. The potential within assessment to maintain and make explicit this particular organisation within the school, I termed the "organising potential" of assessment. For example: assessment practices make it possible to describe students as 'weak' or 'strong' in a particular topic of school mathematics, and therefore provide a means by which 'weak' students can be grouped together and identified as the 'standard grade' class, and students who achieve high marks can be grouped together and identified as the 'higher grade' class. Clearly assessment is not the only element within school which has potential for sustaining the organisation of schooling in a particular way, as elements such as the division of the schooling experience into years, the separation of students into different standards, the structure of the school time-table, the physical arrangement of desks and the architectural structure of the school, all maintain a particular form of organisation. Assessment practices however enter into the organisational structure of the school by allowing for students to be described in very particular ways, and it is to this that I now want to turn.

THE DESCRIPTION AND CONSTRUCTION OF STUDENTS AS SUBJECTS

In an attempt to describe the organising potential of assessment in relation to the description and construction of students, I want to draw on the work of Michel Foucault (1982). One of the main objectives, he claims, of his writing, has been to describe historically the different ways in which human beings are made subjects. Foucault(1982) comments:

> ...the goal of my work during the last twenty years... has not been to analyse the phenomena of power, nor to elaborate the foundations of such an analysis. My objective, instead has been to create a history of the different modes by which, in our culture, human beings are made subjects (p208).

Foucault identifies three such "modes of objectification". One particular mode is of interest to this paper, what Foucault describes as "dividing practices". These dividing practices exist where

> the subject is either divided inside himself (sic) or divided from others. This process objectivizes him. Examples are the mad and the sane, the sick and the healthy, the criminals and the "good boys" (p208).

Assessment represents one particular form of these dividing practices. It is assessment that divides pupils from others by positioning the student within a particular standard and then again positioning the student either on the level of higher grade or on the level of standard grade within a particular subject. It is assessment which allows a pupil to divide him/herself in terms of being good at some subjects and being bad at others, or in terms of needing to work harder at some areas of mathematics and not at others.

The role of assessment is to describe the student in terms of a particular organising structure, a structure which divides and separates. It is not a structure which unifies but rather a structure which makes more evident differences, which highlights gaps and which provides a means of description to sustain this division.

I will go on, in the next chapter to suggest that what sustains these divisions is the naming principle. This Foucault highlights in the above quotation. What sustains the distinction between the mad and the sane, the good and the bad, is the use of a naming principle by which they can be identified and differentiated. Assessment practices make use of this same principle by distinguishing between difficult and easy, basic and complex, and in describing the student in terms of his/her ability or inability. It is the potential provided by assessment practices to name students and to name their abilities, that organise them in particular ways. Assessment provides a particular organisational structure to the description of the student. In many instances this is supported by other forms of organisation which exist in the school, such as, for instance, the provision of different classrooms for different standards, or the provision of different syllabuses for different ability groups as in the case of a higher grade mathematics syllabus and a standard grade mathematics syllabus. The question that needs to be asked is how is it that assessment provides this organisational structuring to the description of the student?

<u>Assessment and Normalisation.</u>

Foucault does not refer to assessment practices as simply descriptive, but refers to them as a modern form of surveillance. Hargreaves (1989), commenting on the work of Foucault, argues as follows:

> At the heart of such systems of surveillance, Foucault argues, are two central principles: normalizing and hierarchy. Normalization or normalizing judgments, involves comparing, differentiating, homogenizing, and excluding people in relation to assumed 'norms' or standards of what is proper, reasonable, desirable and efficient (p134).

It is these two principles which underpin the organisational structure of assessment practices. Assessment establishes what is considered "normal" or accepted forms of response on the part of students, what Bernstein(1975) refers to as a "valid realisation" of knowledge (p85). Assessment determines what is considered to be valid realisations of mathematical knowledge and these realisations come be regarded as "normal". On the basis of what is considered to be normal, pupils are then compared, differentiated and homogenised. Assessment leads to a homogenous description of pupils, allowing pupils to be described in terms of their achievements which are measured in terms of an accepted norm.

The hierarchisation of students is achieved by noting the degree to which students meet the standards which assessment has established as "normal". Those achieving a high degree of conformity are regarded as more successful than those students failing to conform. Students are then placed into different classes according to this description. The more successful students are placed in Higher grade classes, while the less successful are placed in Standard or Lower grade classes. This process effectively differentiates between "able" and "less able" students.

The comparison, differentiation, and homogenisation of students, and the exclusion of students who do not meet expected standards, are part of the organising principle of assessment practices. My argument is that this organising principle, or in Foucault's terms, "normalising judgment", within which particular descriptions of the mathematics students are embedded, creates, along with other organising principles mentioned above, a particular understanding of mathematics which is evident in the text that I have analysed.

I have attempted to develop within this chapter a discussion of how assessment practices both organise mathematics in certain ways, and construct a particular description of students. My theoretical framework has focused on how descriptions of students are structured and generated by assessment, a structuring that divides and names. I have also looked at how the organisation of school mathematics in turn is structured by assessment and how this works with the regulative features of schooling. These three elements work together in a dynamic way. The rules underpinning this regulative discourse, I have attempted to argue, leads to a particular understanding of school mathematics, as it is within this discourse that students describe themselves or within which they are described.

CHAPTER 5

ANALYSIS OF DATA

The focus of this analysis is on how assessment practices produce particular utterances by pupils and teachers about school mathematics, about learners and about the learning of school mathematics. I have developed my discussion around two themes, namely the way in which school mathematics is constructed and the construction of the learner. These two themes will form the two major sections of this chapter.

I am approaching this analysis from the theoretical position developed in Chapter Four in which I argued that the construction of the learner is dependent on a particular view of school mathematics and that both of these are framed by assessment practices. The text will therefore be analysed from this perspective. Although I have attempted to separate the text into comments about school mathematics and comments about learners, the distinction is not easy to maintain and therefore there will be a measure of overlap in the discussion.

In this chapter I highlight what I believe are three dominant notions of mathematics evident in the text. These are that:

1. Mathematics is fragmentary
2. Mathematics is hierarchical
3. Mathematics is about learning and recognising rules.

I will attempt to argue that the construction of the mathematics learner, as made visible within the text, is predicated on these three notions of mathematics and that assessment practices frame what is said about mathematics and what is said about the mathematics learner.

It needs to be pointed out that the analysis is a description of a reading of the text drawing on the ideas I have outlined above. As a result it is not exhaustive.

THE CONSTRUCTION OF MATHEMATICS

Both the pupils and the teacher interviewed use a particular device when speaking about mathematics. I choose just some of the examples from the text (as there are many) to illustrate this. This device is to speak about mathematics in terms of a spatial entity where mathematics is fragmented into different areas, topics, parts and points. This fragmentation occurs on two levels: on the one level, mathematics is divided within years, and on the other, mathematics is divided between years. I will look at each in turn.

The Fragmentation of Mathematics within Years.

This fragmentation is evident in utterances by the pupils in which they make reference to "areas" and "points" within mathematics:

> **Pete** - Do you think assessment has any purpose for you as a pupil?
> **Ingrid** - Well it helps you so that you know where you are as well, so you know where you have to work more harder at... which areas need more work and... which one's don't.
>
> (2:10 - 2:12)[2]

I want to highlight a particular phrase from the above extract which illustrates this fragmentation. This is the phrase "which areas need more work and... which one's don't." This phrase suggest two things:

[2]Interview transcription number two, lines ten to twelve.

1. that there are particular areas of mathematics which can be identified and

2. that these areas can be distinguished from one another.

In the above example, the distinction between areas is made visible to the student by the establishment of a particular association between area and amount of work. Assessment practices produce this association. Without assessment the use of the phrase "need more work" would not make sense. It is assessment which establishes this need and in so doing divides the subject into areas that need more work and areas that do not. Assessment practices make this distinction evident and as a result produce a space in which students can talk about different "areas" of mathematics.

The potential of assessment in providing the discursive tools with which to talk about mathematics in a certain way is even more evident in the following example:

> **Pete** - Ingrid you got forty-five out of fifty?
> **Ingrid** - Yes.
> **Pete** - How did you interpret that score?
> **Ingrid** - I was very pleased with it. I didn't know I'd get that high but I was very happy with it cos I had been working quite hard at graphs because I always thought that was my... weak point and then I was very pleased to get that result. (2:40 - 2:47)

I want to concentrate in this example on two phenomenon - the use of the phrase "weak point" and the phrase " I had been working quite hard at graphs" - to illustrate my argument.

In order for fragmentation to be sustained, in order for the notion of different areas to preserved, there has to be something which maintains the separation. It is in naming, in giving a title to a particular category, that fragmentation is upheld. It is not the naming that leads to the fragmentation but it is the naming that maintains the distinction between different areas.

Let me return to the above example. The description of a point as "weak" is highlighting a certain element which is only recognisable as a result of assessment practices. Without a discursive framework in which the term "weak" makes sense this description could not be used. What assessment practices do is to highlight the student's position in relation to an expected standard and then provide the discursive framework within which this position can be described. In other words assessment practices provide what I have described as the "organising potential". It is this organising potential which makes possible a particular description of the student which in turn relies on a particular view of mathematics. This view of mathematics does not exist external to the discourse surrounding the mathematics student. What I am suggesting is that assessment practices, in describing a mathematics student in a particular way, assume a particular view of mathematics which is then articulated by both students and teachers. In this way assessment practices produce a particular view of mathematics.

In the above extract Ingrid also remarks "I had been working quite hard at graphs". This comment suggests that "graphs" is represented by a certain form of work which can be distinguished from other forms and which can be recognised in a test. Since it is the test which examines "graphs" by posing certain questions which can be organised under this heading, it allows Ingrid to classify her work in this way. Assessment practices make use of this form of organisation to classify tests. The following extract will make this clear although the reference is here to parabolas:

> **Pete** - You never find that there is something left out in a test?
> **Deon** - Well they didn't put parabolas in here.
> **Ingrid** - Well we knew it wasn't going to be on parabolas though.
> **Deon** - Oh it wasn't. Sorry.

> **Ingrid** - No. This test covered all the basis things which we needed to know.
> **Deon** - Well covered everything that... that they told us to learn for the test.(2:670 - 2:677)

Two important things are highlighted by this extract. The first is that pupils recognise that areas of work can be named as they freely use the term "parabolas" to refer to a section of work. Secondly, in support of the above argument, tests "cover" certain areas of work, legitimating a particular form of reference that Ingrid uses above. It is this which allows a particular discursive space to develop - a space in which the students can refer to "areas" of work and describe themselves in relation to these areas.

One consequence of this view of mathematics is the development of what Ridgeway and Passey (1993) describe as an "exchange" or "economic" view of learning. This was evident in a particular statement that Julie made in the interview that I conducted with her:

> **Pete** - How do you think your pupils or pupils generally would respond to a test item that they had not seen at all?
> **Julie** - ...It doesn't really worry my class. I mean I... in this... was it this test? There was a question... (looks at the question paper) Ja: "Write the domain...". I hadn't done it yet. I hadn't done Domain and Range, and it was only one mark. So I didn't worry about it... So I don't think it is that much of a problem unless it counts a significant amount of marks. But if it is just a small section, three or four marks, they are not going to worry too much about it.
> (3.489 - 3.507)

I want to draw attention to the last remark made by Julie: "... if it is just small section, three or four marks, they are not going to worry too much about it." It is clear from this remark that the fragmentation of mathematics into different areas is clearly linked with an appropriate allocation of marks. The allocation of marks is decided on the "size" of the section that is to be learned by the students. This is even more clearly evidenced in an earlier discussion I had with Steven and Jackie:

> **Jackie** - We hadn't actually learnt domain though.
> **Pete** - You hadn't learnt it yet?
> **Jackie** - No, we hadn't gone through... we hadn't gone through domain before we got the test.
> (1.391 - 1.394)

She comments later:

> **Jackie** - I hadn't heard of it until I got the paper and I thought: "Oh no. This isn't fair". And then I looked and it was only one mark and so I thought: Okay. It doesn't matter.
> (1.416 - 1.418)

The fact that the section on Domain and Range was considered not to matter by Jackie was because it was only worth "one mark". This allocation of marks is linked to the fragmentation of mathematics into different areas, and in the situation which the above extracts highlight, leads to a distinction between what I have termed High-value knowledge and Low-value knowledge. High-value knowledge is what translates into a high medium of exchange, in other words a lot of marks, and Low-value knowledge is what translates into a few marks. This I would suggest is as a direct result of the fragmentation of mathematics into different areas and sections.

What I have attempted to argue in this section is that assessment practices provide the organising potential which is instrumental in describing mathematics students in a particular way. This process leads to the description of mathematics as fragmentary, consisting of areas and points within years, as can be seen in the above extract, and to a distinction between High-value knowledge and Low-value knowledge. I want to now turn to a discussion of the fragmentation of mathematics between years.

The Fragmentation of Mathematics between Years.

I have established above that there is an organising potential which is provided by assessment and which leads to a particular articulation of mathematics. I will argue in this section that this organising potential allows pupils to speak of mathematics as being divided between years. This division is implied in the following extract:

> **Pete** - You said he showed us... he showed it to us before. Before what?
> **Ingrid** - Before the test.
> **Deon** - Not directly. You know during the lesson.
> **Ingrid** - In... in his teaching, ja during the lessons.
> **Deon** - All this sort of stuff...
> **Ingrid** - When you... when you... if you ask something and he will just explain it to you how you find that out.
> **Deon** - And sometimes he often goes a bit further.
> (2:248 - 2:258)

I will pause at this point in the extract and draw attention to the comment by Deon in the last line: "...sometimes he often goes a bit further". In Deon's view there exists a certain boundary within which the standard eight syllabus has to remain. This boundary is well-defined and can clearly reveal to the pupils when the teacher is teaching within it, or in the case of Mr. Dunn above, extending it. Deon goes on to say:

> **Deon** - And I said to him : surely if you think about it, you can't give that tangent a gradient because the gradient depends on the point where it touches the parabola. So he said: oh that's calculus and then he sort of showed me how they do it, you know where using an infinitesimally small thing where you take the tangent and then you go closer and closer to the ideal. And he just went through that quickly so that I would have an understanding of... he quite often does that even

though it's not nearly what we do.
(2:266 - 2:279)

Calculus is "not nearly what (the standard eight class) do". Deon recognises this as is apparent from the two statements that I have highlighted. In both cases reference is being made to the standard eight syllabus which takes place within a particular time frame. It is within this time frame that the standard eight work has to take place. This element of a time limit on the acquisition of standard eight work is evident in the next extract:

> **Pete** - You said he (Mr. Dunn - their class teacher) gave you some more difficult stuff?
> **Ingrid** - Yes. And then he often said this is actually only Standard nine work but it was a bit too late.
> **Pete** - So he taught you stuff in class and he didn't test you on that stuff?
> **Deon** - No, but it will help us next year.
> (2:82 - 2:91)

There is the establishment of a particular time frame within which standard eight work has to fall. Now this might not be too revealing as we are all familiar with the fact that syllabi are constructed on a yearly basis, but what I want to point to here is the temporal element within the pedagogical relationship that pupils find themselves in. The students recognise themselves as standard eight students and they recognise that there is a particular form of mathematics which corresponds with their position in the schooling experience. What marks the transition from standard eight to standard nine is an end-of-year examination which students have to pass successfully. In other words, what punctuates this time frame is assessment practices. There is at the end of the year a standard eight mathematics examination which marks the transition from one syllabus to another, from standard eight work to standard nine work, from a position where calculus is "not nearly" what the students do, to a position where it is. This was made even more explicit in a discussion I had with Deon about being tested on calculus. Deon responds:

> **Deon** - I would feel a bit irritated cos it is like, you know, extra stuff.
> **Pete** - What do you mean extra stuff?
> **Deon** - Well I mean calculus is not standard eight work. (2:1074 - 2:1077)

The organising potential in this case characterises a certain section of work and gives it a name thereby legitimating a certain form of reference. Students can speak about the standard eight syllabus, they can speak about work belonging to the next standard, and they can recognise that a teacher has extended the boundary of the work they are meant to do. In this way mathematics is fragmented into topics between years, a fragmentation that is made possible by the practices of assessment.

I have argued in the above section that assessment practices generate particular statements about students which are both underpinned by, and produce, a view of mathematics as fragmented, consisting of points, areas, and topics between and within years. I want to now turn to a discussion of mathematics as hierarchical.

Mathematics as Hierarchical.

What is necessary for a notion of hierarchy is a view of mathematics as fragmented. Assessment practices, I have argued, produce this notion of fragmentation, both within and between years. However, fragmentation is not a sufficient condition for a hierarchical view of mathematics. The concept of hierarchy depends on a recognition of a distinction between different levels. What I will attempt to show in this section is that assessment practices generate particular statements about students and learning, which are underpinned by a notion of different levels, and which in turn produce a view of mathematics as hierarchical.

Deon, during our discussion on the maths that is done at school, makes the following observation:

> **Deon** - I think everything which we've learnt from junior school is all building up to algebra, geometry and trig. See what I mean? I mean the whole number concept, you know learning sets and then learning number lines and... you know that's all tied in with the different spheres.
> (2:649 -2:655)

The notion of hierarchy is evident in this extract in the metaphor "building up". Deon uses this construction metaphor to describe his learning of mathematics in terms of a progression from the mathematics at junior school to the mathematics he is doing now at secondary school. Junior school mathematics in this description is at a different level to that of algebra, geometry and trigonometry, and assessment practices simultaneously punctuate these different levels and legitimate the movement from one level to the next. It is part of the practice of assessment to describe students in terms of their position within the school, indeed even the distinction between "junior" and "secondary" is part of the practice of assessment. I want to suggest that assessment practices, in marking the transition from Junior school to Secondary school, from "learning sets" to "learning number lines", make students aware of this organising potential - the notion of hierarchy - and therefore legitimate a particular form of discourse that Deon uses in the above extract whereby he can speak of learning as a process of "building up".

Let me turn to an example of this distinction of different levels at a more micro-level. Jackie at one point during the interview describes mathematics as "pointless". This prompted the following discussion:

Pete - How much maths that you are doing at the moment is pointless?
Jackie - Most of it. All of it actually. We don't ever use... I mean we don't do basic maths. Except... okay you use it for adding and multiplying while you're factorising or while you are doing algebra.
Steven - There's always... there is like a fundamental part... and then you use that, that's all you use in all the more advanced... the work that you do. But the more advanced work, some of it...
Jackie - ...is pointless.
Steven - You don't really need it, ja.
(1:223 - 1:234)

What is evident again in this text is the notion of hierarchy apparent in the distinction between "basic" mathematics and "more advanced work". Both Steven and Jackie recognise this distinction, and the notion of hierarchy can be clearly seen in the phrases that they use. This notion of hierarchy, I have suggested, is on a more micro-level since it is visible to the students within the mathematics that they are doing and not, as in the example with Deon above, a recognition of a hierarchy between years. So it could be argued that this notion of hierarchy exists, as in the fragmentation of mathematics, between and within years.

The distinction between different levels within the mathematics they are doing is also visible to the students in the tests that they write:

Pete - Do you think the all the stuff that's important is covered by the test? All the important aspects of mathematics are covered by the tests?
Deon - Ja.
Ingrid - Yes.
Pete - There is nothing left out?
Deon - The basic things which you need as a foundation...
Ingrid - The general things are covered.
Deon - Ja. (2:658 - 2:669)

Again, evident in this example is the notion of "basic" mathematics which is needed as some sort of foundation and which both Deon and Ingrid recognise.

The notion of hierarchy can be clearly seen in each of the three examples that I have highlighted . There is clear evidence of the separation between different levels - between the basic and the more advanced - and these references are all with regard to mathematics.

My argument is that the organising potential of assessment practices underlie these descriptions of mathematics. I have highlighted two dominant notions so far in my discussion - the notion of the fragmentation of mathematics and the notion of hierarchy. I want to now turn to a discussion of a third notion apparent in the text - that mathematics is about learning and recognising rules. I will then attempt to show how descriptions of the student which are part of the practices of assessment, are reliant on these three views of mathematics.

Mathematics - Learning and Recognising Rules.

Examples from the text which I have chosen to represent this phenomenon, are characterised by phrases and terms like "should" and "ought to" - terms which suggest the acknowledgement of an authority which the pupils felt they had to obey when doing mathematics. It will be evident in the examples that I have highlighted that this becomes the focus of the students' attention in learning mathematics.

Discussing the difference between easy and difficult problems, Ingrid and I engaged in the following discussion:

Pete - How do you describe more difficult questions?
Ingrid - Those are the one's where you don't know... what parts of the information you were supposed to use and when. (2:282 - 2:286)

I want to draw attention to a particular phrase in Ingrid's response - " ...what parts of the information you were supposed to use and when". Inherent in this comment is the recognition of some form of authority that regulates what information is regarded as useful and when. Ingrid recognises in the text that she is "supposed" to only use parts of the information that she is given. In other words, within the question in the test is some sort of reference - a clue if you like - of the information that she is supposed to choose and of the timing in using that information. According to Ingrid, difficult questions do not make this explicit. In contrast she says the following about easy questions:

Pete - Some people would say that an easy question is a question where you can see the answer immediately. You look at the question and you go: Okay, I know what the answer is. All I have to do is now write it down.
Ingrid - I never know the answer but at least I know how to find the answer. That's what I think is easy. If you know how to find it... if you look at it and immediately know what to do. (2:302 - 2:308)

In this comment, the clue or the rule that is hidden in the difficult question is more explicit - "you look at it and immediately know what to do". There is a "rule" inherent within the question which reveals to the student "what to do", whether it is to choose only parts of the information as in the above example, or whether it is to do something else. There is not an element of choice on the part of the pupil involved in the "doing" of the question. What is involved is identifying what one as a pupil is "supposed" to do, and the recognition of this explicit or implicit rule is what distinguishes difficult from easy questions.

What needs to be asked is how these rules are learnt by the pupils and why some students find some questions difficult and some questions easy? I asked Ingrid to explain this phenomenon to me.

> **Pete** - Why do you think different people find different questions easy and other questions hard?
> **Ingrid** - I think it... depends on whether they learnt the method and whether they did enough examples of it... if you only did about one example then you would find another example quite difficult. (2:438,439; 2:453 - 2:456)

Ingrid focuses on two aspects which I believe are characteristic of the notion that mathematics is about learning and recognising rules, namely methods and examples. I have already argued that the recognition of difficult or easy questions depends on identifying the rule (sometimes explicit, sometimes implicit) in the question which reveals to the pupil what they are supposed to do. The recognition of this rule depends on the pupil learning "the method" and then doing "enough examples" of it. The text suggests that Ingrid recognises that there are "methods" for questions and the learning of these makes questions easy or difficult depending on the number of examples one does.

There are two comments which I want to make concerning "the method" that Ingrid identifies here as being a vital characteristic distinguishing between difficult and easy questions. The first is that it becomes the focus of study. Deon and Ingrid, in discussing test preparation, comment:

> **Deon** - ...I don't think that you can really study for maths. I mean you could... you could...
> **Ingrid** - You can study the methods though...
> (2:715 - 2:717)

and later

> **Deon** - ...okay you can study a few things like methods as Ingrid said...
> **Ingrid** - And then do many examples.
> **Deon** - But most of it... it has to be... you have to understand the concept, and if you... if you understand the concept then... you should be alright...
> **Pete** - There's this set concept in your mind that you have to understand?
> **Deon** - Ja, ja. A way of doing something.
> (2:722 - 2:733)

Although Deon tries to argue that one cannot really study for mathematics what he finally admits to is that one has to "understand the concept" which in his own words is a "way of doing something". Ingrid recognises this way of doing something as a "method" and not as a concept, but both of the pupils identify the focus of their study on "methods". Deon simply disagrees with the extent to which one can study methods and believes that it requires "understanding". For Ingrid though these methods are very important. She comments later:

> **Ingrid** - I have to know what is going on cause I am a very organised person and I have to know how to do it and why... why I am doing it and exactly what I'm... what steps I have to follow.
> (2:751 - 2:753)

and again later:

> **Ingrid** - ...what just bothers me is whether I will be able to know... whether I know enough information... whether I will know the method to answer all... some of the questions.
> (2:1045 - 2:1047)

The "method" is the rule which is implicit or explicit and contained within the question. It is the focus of the study of the pupils and is the essential component separating difficult and easy questions. It is a rule which defines what "should" be done and "when" and informs the pupil about what information should be used.

The second comment I want to make concerning "the methods" is that it forms a fundamental part of mathematics, as can be seen in the following example. In the following extract, Ingrid and I discuss the difference between school mathematics and mathematics that forms part of the Mathematics Olympiad competitions:

> **Pete** - You make a distinction between the mathematics we learn at school and this Maths Olympiad. Do you think they are different mathematics types - they're different types of mathematics?
> **Ingrid** - Maybe it's because sometimes you just don't know the whole concept that you're supposed to know... they teach you everything you need to know in school, but for those competitions it is different cause you don't know any of the concepts and it's just... you have to think it through yourself and... use what you've been taught... but sometimes that's just very difficult I think.
> (2:778 - 2:790)

Mathematics is about learning and recognising rules which Ingrid in this extract describes as "the whole concept" which she is "supposed to know". The rules governing school mathematics are taught : "...they teach you everything you need to know in school..." and it is this which separates school mathematics and mathematics which forms part of the Mathematics Olympiad competitions.

What is evident in the examples that I have highlighted is the notion that mathematics is about learning and recognising rules. My argument is that assessment practices make this explicit to the pupils. I want to now turn to a discussion of the construction of the learner.

THE CONSTRUCTION OF THE LEARNER

Within the text, the construction of the mathematics learner is achieved in a several different ways. I want to highlight two of these and then attempt to describe :

a. how each is framed by assessment practices and
b. how each is predicated on a certain view of mathematics - a view which I have highlighted in the first section of this chapter.

The construction of the mathematics learner within the text centres around two components:

1. The description of the learner in relation to mathematics
2. The description of the learner in relation to other learners

I will look at each in turn.

<u>The Description of the Learner in Relation to Mathematics.</u>

Within the text there is evidence of a classificatory principle underlying the pupils' comments about mathematics. This classificatory principle is the distinction within the text between difficult and easy. The pupils make several comments indicative of this distinction:

> **Ingrid** - It just seemed more difficult to me... it actually required much more. You had to grasp the whole idea and that (the test) was more simple because that stuff was in the textbook as well. (2:98 - 2:100)

Earlier on she stated:

> **Ingrid** - Mr. Dunn has been giving us more extra work that was... that was much more difficult than the test. (2:70 - 2:71)

In the above examples, a definite distinction between difficult and easy is apparent. In using the terms "difficult" and "easy", Ingrid is describing her position as a learner in relation to mathematics: " It just seemed more difficult to me...". There is an underlying principle by which Ingrid classifies questions as difficult or easy and in doing so she describes herself as a learner in relation to the subject. It would be inappropriate here to give examples of all the instances within the text where this form of distinction took place. What I want to do is rather represent it in a form of a table to demonstrate the polarities that were evident in the text.

The phrases in italics are my own and have been inserted in order to demonstrate more clearly the polarity that exists in the text which is characterised by the distinction between difficult and easy.

Difficult	Distinction Easy
more work	*less work*
work more harder	*work less harder*
more difficult	more simple
difficult	easy
more complex	the basic stuff
much more difficult	much easier

Table 1.

I am attempting to indicate, in the setting out of the text in this fashion, that within the text there is evidence of a form of classification which takes the shape of a polarity. The distinction in this polarity is between difficult and easy questions within mathematics.

In Table 2 , which follows on the next page, I have set out in the same manner the reasons pupils give for describing questions either as difficult or easy. What is evident in these tables is that within the text there is a possibility of two voices. These two voices are a product of their positioning in relation to mathematics. On the right is an example of the voice located in, what I want to call, a "strong" position in relation to mathematics. This voice identifies questions as easy and simple and basic and is positioned as a competent user of the methods and as one who has done enough examples. The strong voice knows "what to look for" and "how to find it". It is a voice full of confidence. On the contrary, the voice on the left is in a weak position in relation to mathematics. This voice identifies questions as difficult and more complex.

Reasons

Difficult	Easy
sometimes you don't see it	sometimes you see it
doesn't come naturally	comes naturally
don't know how	*do know how*
not straightforward	can straightforwardly see
don't know how to find it	know how to find it
don't know what to do	know what to do
don't know how to do it	know how to do it
don't know what to look for	know what to look for
didn't learn the method	learnt the method
didn't do enough examples	did enough examples

Table 2.

My point is that the positioning of the voice, which is in fact a description of the student through assessment practices, relies on a particular view of mathematics. This view is characterised by the reasons given in Table 2 and is a perception which sees mathematics as being about learning and recognising rules.

What is evident in the interviews is two forms of descriptions of the student. One is biographical and is the description of the student by the teacher, while the second is autobiographical and is a description of students of themselves. The phrases which I have represented in Table 1 are examples of this autobiographical description. However, even though students are describing themselves, it is a descriptive discourse which is underlined by an organising potential which assessment practices make visible to the student. I want to return to a part of the text which I quoted earlier which will highlight the role that assessment plays in providing this descriptive language:

> **Pete** - Do you think assessment has any purpose for you as a pupil?
> **Ingrid** - Well it helps you so that you know where you are as well, so you know where you have to work more harder at... which areas need more work and which ones don't. That you have... something to tell you what your work is like at the moment. (2:10 - 2:12)

Two phrases in this extract support my contention. These are the phrases "it helps you" and "that you have... something to tell you". **Assessment practices provide the descriptive language with which students can describe themselves.** This language, as I have suggested in the opening section, is predicated on a particular notion of mathematics. It is a language which is centred on describing the student in a particular way in relation to a particular view of mathematics. The role of assessment is a descriptive one, "...to tell you what your work is like at the moment" and it is in describing that assessment practices position the student.

This positioning of the student was also evident in the interview that I conducted with the teacher. I questioned Julie on how a test paper was set within the school to cater for the different classes. She responded:

> **Julie** - What happens here is we set the exam and then it gets rotated through all the teachers for comment. So being the lowest set... I obviously can't expect them to set it to my standards. So what I would look for is... questions that my kids could do and I would see what the marks would come out to... or how many marks of the paper they would be able to do.And I am sure that if it's at least sixty or seventy percent of the paper then I would leave it. Because ultimately they are going to be able to do sixty or seventy percent of the paper - that is their ability level.(3:405 - 3:415)

Assessment practices allow Julie to describe "her" students in terms of their "ability level". The students in Julie's class are positioned in relation to mathematics within a particular descriptive discourse generated by assessment. However, within this discourse is a particular notion of mathematics that is evident in the phrase: " So what I would look for is... questions that my kids could do...". Mathematics is fragmented into different questions that the pupils can and cannot do and the view of mathematics as a holistic unfragmented subject, it is clear, does not inform the comments made here.

What I have tried to highlight in this section is that the construction of the student is made possible through assessment practices but that this is predicated on a particular notion of mathematics. Inherent within assessment practices is a potential for describing the student in a particular way in relation to mathematics - what I have termed earlier an "organising potential". However this "organising potential" effectively constructs mathematics in a particular way in describing the student. Two notions of mathematics are evident in the above section

- the notion that mathematics is fragmentary and the notion that mathematics is about learning and recognising rules. I want to now turn to the second component evident in the text by which the learner is constructed.

The Description of the Learner in Relation to Other Learners

Assessment practices allow for a description of the student in relation to other students. Assessment practices categorise students so that their position within school is described in terms of the position of others within the schooling environment. This is nowhere more evident within in the text than in the notion of streaming.

Julie, in discussing the test which formed the basis of this study, makes the following comment:

> **Julie** - I actually think that this test was a little easy, if I remember correctly. I think that the top classes did very well in it. You see, because I got the bottom set, I always feel sorry for my kids so you've got to think of that. (3:74 - 3:77)

The distinction between "top" and "bottom" is immediately obvious. The distinction between top and bottom is a reference to the hierarchical arrangement of classes who are on higher grade. Within the standard eight group there is also a distinction between a higher grade group and a standard grade group. I asked Julie how the children are allocated to the different groupings:

> **Pete** - How are those standard grade classes chosen? On what basis are they chosen?
> **Julie** - On their marks that they've got. So if they failed higher grade badly like below... is it a G? No. Well they've got to get forty on higher grade. I think it's anybody who got below forty, in the thirties, was strongly encouraged - we don't force in this school - to go onto standard grade. Some we sort of strongly encourage... So

> whatever mark they got in the exam will determine to which class they go. (3:117 - 3:126)

It is evident in the text that assessment practices lead to a very clear positioning of the student in relation to other students. Students are described either as part of the "standard" grade group or as part of the "higher" grade group - terms which only have meaning in relation to one another. Without the standard grade grouping there would be no higher grade grouping and vice versa. Even within the higher grade grouping there is a hierarchical arrangement, a difference between a top set and a bottom set. Again these terms only have meaning in relation to one another. Without a "top" set there would be no "bottom" set and vice versa. It is in this way that students are constructed in a particular manner in relation to each other.

However the organisation of the standard eight mathematics group in this hierarchical fashion maintains a particular organisation of mathematics, a view of mathematics as hierarchical. This comes about as a result of the distinction between top and bottom, between higher grade and standard grade. Mathematics is hierarchically organised into a distinction between easy and difficult, a distinction between easy and more complex. This is evident in the text in a number of instances. I will highlight three examples here. Julie indirectly draws on this notion in the following extract:

> **Pete** - Pupils who don't go onto standard grade, what happens to them?
> **Julie** - ...Those kids, their lives at school are a nightmare because they don't enjoy the subject... It is a continuous battle for them to try and get through. But I just think that if a child is struggling, really struggling on higher grade, I say go and do it on standard grade. A child who gets an E on higher grade and who hates maths could go down onto standard grade and get an A.
> (3:129 - 3:130;3:138 - 3:144)

The notion of mathematics as being hierarchically arranged to correspond to the standard grade/higher grade distinction is evident here in two instances. Firstly, in the idea put forward in the text that the movement from higher grade to standard grade is "down", and secondly, in the suggestion that this downward movement by the student will result in improved marks. Julie is indirectly suggesting that mathematics on the standard grade is easier than mathematics on the higher grade, or that mathematics on the higher grade is more difficult.

This is even more explicit in the following extracts. In a discussion with Jackie about the test that they had an important reference to higher grade is made:

> **Pete** - What do you think of this particular test that you wrote here? What do you think they were testing?
> **Jackie** - Application again.
> **Pete** - Application. You've got this word application. Where have you heard that word before?
> **Jackie** - Teachers.
> **Steven** - They say: In higher grade they ask you more application.
> **Jackie** - Ja, application. More how... you're able to apply stuff than regurgitate it.
> (1:885 -1:894)

Higher grade mathematics is concerned with "more application" and which is decidedly different from just "regurgitating" it. What is suggested in this comment is that mathematics can be separated into application which corresponds with the level of higher grade and elements which can be simply regurgitated.

This notion of hierarchy evident in mathematics is also assumed in the following extract. In this extract Julie is talking about higher grade exams. She comments:

> **Julie** - Especially on higher grade. I mean here... you teach the basics but the questions at the end of the year... won't just be straightforward: Find the equation of the graph. It is going to be linked up in some other way and they know it. (3:341 - 3:345)

and later

> **Julie** - You know on higher grade you don't... you very seldom get straightforward questions. Just sort of: Solve for this or solve for that... (3:351 - 3:353)

The point is that higher grade and the mathematics that corresponds to this level is not "straightforward". Underpinning this notion however is the assumption that mathematics can be hierarchically organised into levels where some mathematics is not simply "straightforward" while other parts (and I use that word with caution) are.

What I have argued in this section is that the student is described in relation to other students within the discourse of streaming - a discourse which assessment practices legitimates. However underpinning this hierarchical arrangement of the student is the notion that mathematics can also be arranged hierarchically and separated into levels of difficultly.

The focus of this chapter has been on how assessment practices produce particular utterances by pupils and teachers about mathematics, about learners and about the learning of mathematics. The discussion has centred around two themes - the way in which mathematics is constructed and the construction of the learner. I have highlight in this chapter what I believe are three dominant notions of mathematics evident in the text. These are that:

1. Mathematics is fragmentary
2. Mathematics is hierarchical
3. Mathematics is about learning and recognising rules.

I have argued that the construction of the mathematics learner, as made visible within the text, is predicated on these three notions of mathematics and that assessment practices frame what is said about mathematics and what is said about the mathematics learner. I have attempted to describe this framing in terms of what I have called "the organising potential" of assessment practices where these practices in providing the discursive space in which the mathematics learner is described, organise notions of mathematics in a particular way.

CHAPTER 6
CONCLUSION

The focus of this research paper has been on how assessment practices construct teachers' and pupils' views of mathematics. I have argued that assessment practices maintain and make explicit rules of social order which form part of the organisational structure of the school. Assessment practices do this by providing particular descriptions of students that conform to a particular organisation of school subjects. The capacity of assessment practices to do this, I have termed the organising potential of assessment practices. I argued in Chapter Four that subjects are appropriated from other areas of production outside of the school, and are then embedded within a particular social organisation within the school, governed by rules of order, relation and identity. The way in which these subjects are transmitted by the teacher and reproduced by the students, depends on the social organisation of the school and not on the internal organisation of the subject.

Assessment practices allow for a particular description of the student, and this description simultaneously relies on, and sustains, a particular organisation of mathematics. This organisation of mathematics is not internal to the subject, but is produced by the social organisation of the school and by rules governing this organisation. The social organisation of the school centres around individualising students and describing them in particular ways to maintain this individuality. It is an organisation which Foucault (1982) describes as a "process of objectification" (p208) and which he describes as a form of power:

> This form of power applies itself to immediate everyday life which categorises the individual, marks him (sic) by his own individuality, attaches to him his own identity, imposes a law of truth on him which he must recognise and which others have

> to recognise in him. There are two meanings to the word subject: subject to someone else by control and dependence, and tied to his own identity by a conscience or self-knowledge. Both meanings suggest a form of power which subjugates and makes subject to (p212).

The social organisation of the school is maintained by rules of order, relation and identity which categorise individuals and attach to them their own identity. Each individual has imposed on him/her a law of truth which is a description of his/her own individuality in terms of ability and types of behaviour which others have to recognise in him/her and which he/she has to recognise in him/herself. Foucault comments:

> Take for example an educational institution:... the activity which ensures apprenticeship and the acquisition of aptitudes or types of behaviour is developed there by means of a whole ensemble of regulated communications (lessons, answers, orders, exhortations, coded signs of obedience, differentiation, marks of "value" of each person and of the levels of knowledge) and by a means of a whole series of power processes (enclosure, surveillance, reward, punishment, and the pyramidal hierarchy) (p218).

Assessment practices exist as a particular message system which regulate and inform lessons, answers, orders and exhortations, and which provide the means by which students can be described in terms of marks of value and in terms of different levels of knowledge, and provide a discourse by which students can be differentiated. Assessment practices sustain this differentiation through, what I termed, the naming principle, and in this way maintain a particular organisation within the school, an organisation which underpins the organisation of mathematics. This leads to an organisation of mathematics evident in the text that was analysed in the previous chapter, namely, that mathematics is fragmentary, hierarchical and consists of learning rules and methods. Assessment practices provide the discourse by which students can be differentiated by describing students in terms of this organisation of mathematics. Students are then described, and describe themselves, in relation to mathematics and in relation to other students.

In the first instance the fragmentation of mathematics into different areas and its' organisation underpinned by a description suggesting that mathematics consists of rules and methods, allows for the development of a distinction between difficult and easy questions. This allows the description of students in terms of which areas need more work and which ones do not. This leads to the differentiation of students into two distinct positions which is highlighted in the text by the evidence of two voices; one in a strong position in relation to mathematics and one in a weak position in relation to mathematics. Students can also be described in terms of their ability level, which is underpinned by this fragmentation of mathematics into different areas. Assessment practices, by providing the discursive framework in which students can be named in terms of these two descriptions, maintain rules of order, relation and identity.

In the second instance, the hierarchical arrangement of mathematics allows for a hierarchical description of students in relation to other students, what Foucault above describes as a power process. Students are described either as part of a standard grade group or as part of a higher grade group, and they are again described in terms of their positioning within these groupings and as belonging to either top or bottom sets. This description is underpinned by an organisation of mathematics as hierarchical, an organisation that is not internal to the subject, but which is produced as a result of the embedding of mathematics in the regulative discourse of the school. This organisation is sustained by assessment practices by allowing students to be named as belonging to a particular grouping.

Assessment practices, it can be seen from the results generated from the particular case-study which this paper has been concerned with, maintain a particular organisation of mathematics and produce a description of mathematics students based on this organisation. I have termed this the organising potential of assessment practices. The role that assessment practices play in constructing pupils' and teachers' views of mathematics, it can be argued from results of this case-study, cannot be ignored, and the lack of research into the affect that assessment practices have on constructions of mathematics needs to be addressed.

I have attempted to argue in this dissertation that assessment practices produce particular utterances by teachers and pupils about school mathematics, about the learning of school mathematics and about learners of school mathematics. This study has focused on a very small sample and although it has generated some interesting ideas, it is limited in terms of its generalisability. This dissertation needs to serve, in a sense, as a pilot study for further research into how assessment produces particular constructions of school mathematics. The study needs to be extended to include several samples from different schools within South Africa. In particular the following questions need to be answered:

1. Are these notions of school mathematics evident at other schools?
2. What other factors, besides assessment practices, contribute to maintaining these notions of school mathematics?
3. Do Standard grade students have the same views of mathematics as Higher grade students? If not, how

do their alternative views produce different descriptions of students?

Inevitably, the question that needs answering is: In what way can a study of this nature aid teachers and students of school mathematics? It is my view that we must become aware of the possible constructions of school mathematics that assessment practices generate in order to develop, what Gaddis and Volmink (1993) citing Skovsmose (1991) term, a "critical mathematical education":

> ...it is essential that we carefully examine implications of assessment practice if we are to move toward establishing a framework, both theoretical and practical, for what Skovsmose (1991) terms **critical mathematical education** (p382).

Critical mathematics education, suggest Gaddis and Volmink, provide students with opportunity to interrogate, criticise, and question the mathematics knowledge that is 'valued' at schools (p383). Criticising the current forms of assessment that dominate schooling, and examining the possible constructions, both of mathematics and of mathematics students that these assessment practices generate, as this dissertation has done, is an attempt to contribute towards developing a critical mathematics education.

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APPENDIX

The interviews were largely unstructured. This schedule was intended as a checklist. I have provided examples in parenthesis of how I actually posed the questions.

Outline of Pupil Interview

1. What do you think are the purposes of assessment? (Do you think assessment has any purpose for you as a pupil?)
2. What did you think this particular test was trying to achieve? (What did you think of this particular test that you wrote? What do you think they were testing?)
3. Do you think tests are designed to test a particular objective? (What do you think tests are for?)
4. Do you feel that tests provide information for you about your ability with regard to mathematics? (Do you think you learn anything from tests about how good you are at mathematics?)
5. What, would you say, were objectives of this test? (What, do you think, this specific test was examining?)
6. How, do you think these objectives are decided? (How do you think teachers work out what they are going to test you on?)
7. Is all the content that is considered important by the teachers covered by the test items? (You never find there is something left out in a test?) (Do you think that all the stuff that is important is covered by the test? Are all the important aspects of mathematics covered by the test?)
8. Are items that are tested only those which have been taught or referred to in class, or are some questions completely unseen? (Do you sometimes get tested on work you have never seen before?)

9. How do you, as students, know how to answer test items? Is it clear from the paper or is it because it is familiar to you?

(How do you know how to answer test questions? Can you see this in the question paper or is it familiar to you?)

10. Do you think that pupils struggle to determine the difference between difficult questions and easy questions?

(How would you describe more difficult questions?)

(Why do you think different people find different questions easy and other questions hard?)

11. How would you describe the difference between difficult and easy questions?

12. Do tests frustrate you? In what way?

13. How do you feel about the time aspect of tests?

14. Do you think that certain forms of mathematics knowledge is emphasised in tests? How would you describe these forms of knowledge?

(Do you think that some things are emphasised in the tests and not others?)

15. When teachers mark your scripts what do you think they are looking for? In other words what do you think they actually mark?

16. How often are you tested?

17. When you answer a test paper what are you concerned with?

18. When your scripts are returned to you what are the first things that you look for?

19. Do you compare results with other people in the class?

20. Do you read the teachers comments on your paper?

21. On certain test answer sheets your teachers wrote the comment "very well done". How does this make you feel? How would you feel if it was left out?

22. If your test paper was evaluated without tick marks and all you got back was a mark at the top of the page how would this make you feel?

23. If you had to suggest some changes to tests in the class what suggestions would you make regarding:

a. Setting of tests

b. Marking of tests

c. Feedback

24. More generally, how would you describe your views of mathematics and how it should be assessed?
(Describe what you think of mathematics and how you think it should be tested?)

<u>Outline of Teacher Interview</u>

1. How would you describe a successful learner?
2. What for you are the purposes of assessment?
3. What did you hope this particular test would achieve?
4. Are tests designed to test a particular objective?
5. What, would you say, were objectives of this test?
6. How did you decide on these objectives?
7. How would you respond to the statement that teachers use tests to differentiate between students?
8. How would you respond to the statement that tests are merely a form of confirming teachers differentiation between "good" and "bad" students?
9. Do teachers use their knowledge of their students to construct the test items? How?
10. On what basis are test items chosen?
11. On what basis are test items excluded?
12. Is all the content that is deemed important by the teachers covered by the test items?
13. How do you as a teacher determine what is important to test?
14. Some might suggest that test items determine the goals of school mathematics teaching rather than the goals of teaching determining which test items are necessary. Do you agree?
15. Are items that are tested only those which have been taught or referred to in class, or are some questions completely unseen?

16. How would pupils respond to a completely unseen test item? (How do you think your pupils, or pupils generally would respond to a test item that they had not seen at all?)

17. How is time allocated to each question?

18. How are marks allocated for each test item?

19. If marks are allocated for each step that the pupils completes successfully, what exactly is a "step"?

20. On what basis are steps awarded/not awarded marks?

21. How does one decide that the standard of a test paper is appropriate? Is it only done once the marks are analysed?

22. How do students know how to answer test items? Is it clear from the paper or is it because it is familiar to them?

23. Would you describe tests as:

    i. a recall of factual knowledge or

    ii. an application of procedures to familiar problems?

24. Do you find that some pupils do not know when a particular question is completed?

25. Do you think that pupils struggle to determine the difference between difficult questions and easy questions?

26. More generally, how would you describe your views of school mathematics and how it should be assessed?