ATTITUDES TOWARDS MATHEMATICS, ACHIEVEMENT IN MATHEMATICS APTITUDE PROBLEMS AND CONCOMITANT TEACHER PRACTICES IN UGANDAN SECONDARY SCHOOLS

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ABSTRACT

ATTITUDES TOWARDS MATHEMATICS, ACHIEVEMENT IN MATHEMATICS APTITUDE PROBLEMS AND CONCOMITANT TEACHER PRACTICES IN UGANDAN SECONDARY SCHOOLS

Key Words: Achievement in Mathematics, Enhancing Participation, Gender Differences in Mathematics, Group Learning, High-Performing schools, Low-Performing schools, Pursuing Excellence, Student Attitudes towards Mathematics, Teacher Practices, Uganda.

The purpose of this study was to investigate student attitudes towards mathematics, achievement in mathematics problem solving and the nature of teacher practices in Ugandan secondary schools. The study was intended to determine if there are any relationships between student attitudes towards mathematics and achievement in mathematics problem solving. And to explore the nature of teacher practices in high performing and low performing schools. The study used a combination of quantitative and qualitative research methods.

Two hundred fifty four students from nine secondary schools and four mathematics teachers participated in the study. The data examined were from (1) senior three (ninth-grade) students' responses to a students' attitude towards mathematics questionnaire modified from the Fennema-Sherman attitudinal Scales

and (2) students' solutions to a mathematics problem solving test that the researcher developed. The reliability of the instrument was examined by computing Cronbach alpha internal reliability coefficient.

The analysis of the quantitative data revealed a low but significant positive correlation between attitudes towards mathematics and achievement. The findings of the study suggest that student attitudes towards mathematics are related to achievement. Furthermore, the results show that in nearly all the comparisons students in the high-performing schools expressed more positive attitudes towards mathematics: they showed lower anxiety, higher confidence and higher motivation than the students in the low performing schools. Students in high performing schools showed higher achievement in mathematics problem solving than the students in the low performing schools. A significant gender difference was found in attitudes towards mathematics in favour of males. But no significant difference in achievement in mathematics problem solving between the sexes were found.

The qualitative analysis of the nature of teacher practices show distinct trends that centred on two constructs: *pursuing excellence* that revealed what teachers say and do to improve student achievement; and *enhancing participation* that revealed what teachers say and do to improve student attitudes towards mathematics and engage students in the learning process. Teachers in high performing schools had more access to resources for teaching and arranged additional teaching sessions. These teachers taught student engaging lessons that incorporated constructivist teaching characteristics through grouping and active participation of the students. Teachers in low performing schools conducted teacher-centred lessons among less active students while teachers in high performing schools conducted student-centred lesson among more active learners.

Results of this study generally support previous research on gender differences regarding student attitudes towards mathematics and achievement in mathematics. Results extend the types of teacher classroom practices reported in the Ugandan schools. Findings of this study have implications for teachers, mathematics educators, policy makers and researchers.

This research concludes that to increase the chances of success in raising student attitudes towards mathematics and to realise higher achievement schools should ensure that teachers have the resources and suitable environment to perform their work. The teachers should be given opportunities to interact and to collaborate with other teachers through teacher-networks and share their experiences between schools and for teacher professional development.

June, 2004

DECLARATION

I declare that ***Attitudes towards Mathematics, Achievement in Mathematics Aptitude Problems and Concomitant Teacher Practices in Ugandan Secondary Schools*** is my own work, that it has not been submitted before for any degree or examination in any other university, and that the sources I have used or quoted have been indicated and acknowledged as complete references.

Name: Charles Opolot-Okurut Date: June, 2004

Signed:.....................................

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LIST OF ACRONYMS

The following Acronyms have been used in the text of this thesis:

ANOVA	-	Analysis of Variance
DEO	-	District Education Officer
DES	-	Department of Education and Science
FIAC	-	Flanders' Interaction Analysis Categories
FIAS	-	Flanders' Interaction Analysis System
HP	-	High Performing
ITEK	-	Institute of Teacher Education, Kyambogo
LOP	-	Lesson Observation Protocol
LP	-	Low Performing
MoE	-	Ministry of Education
MoES	-	Ministry of Education and Sports
MPST	-	Mathematics Problem Solving Test
NAEP	-	National Assessment of Educational Progress
NCDC	-	National Curriculum Development Centre
NCTM	-	National Council of Teachers of Mathematics
NTC	-	National Teachers' College
PTA	-	Parent Teachers Association
PTC	-	Primary Teachers' College
RDC	-	Resident District Commissioner
SATMI	-	Student Attitudes towards Mathematics Inventory
SMEA	-	School Mathematics of East Africa

SMU	-	Secondary Mathematics for Uganda
SPSS	-	Statistical Package for Social Sciences
SSM	-	Secondary School Mathematics
SYTEST	-	System-Teacher-Student
TIG	-	Teacher Interview Guide
TIMSS	-	Third International Mathematics and Science Study
TLAILO	-	Teaching and Learning Assessment Instrument for Lesson Observation
UNCST	-	Uganda National Council for Science and Technology
UNEB	-	Uganda National Examinations Board
UPE	-	Universal Primary Education

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

At the international level, there is a wind of change blowing in education. Educators in most countries are facing a number of educational challenges. Current challenges that are prominent are "innovative teaching strategies; various measures to improve…the quality of teachers; greater attention to 'constructivist'-inspired forms of teaching and learning; and the advent and impact of new technologies on classroom practices" (Hargreaves, Lieberman, Fullan, & Hopkins, 1998:2). Educational systems in various countries are grappling with these challenges by initiating, piloting and implementing changes in education. Some educators have argued that any educational change needs to be backed by empirical data either to base decisions on or to inform the decisions that are arrived at. Consequently research logically follows as one way to provide empirical data to guide changes that may improve education quality.

Meanwhile, there has been much worldwide concern to improve the quality of mathematics education and student achievement in mathematics. For example, the International Academy of Education (IAE) devoted the whole volume-four of their *Educational Practices Series* to improving student achievement in mathematics (Grouws, & Cebulla, 2000). Similarly, the International Association for the Evaluation of Educational Achievement (IEA) conducted the Third International Mathematics and Science Study (TIMSS) that was aimed at measuring student achievement in mathematics and science, and assessing factors that influence the learning of those subjects. In other words, the TIMSS study was meant to investigate the teaching and learning of mathematics and science in each participating country (Martin & Kelly, 1996). Some countries such as the United States are now using the TIMSS results, especially those concerning education systems in countries with high achieving students, to examine and direct their policies and practices concerning mathematics instruction. Such actions resulting from research justify the need for research based empirical data.

In the United States, mathematics education reform initiatives were and are continuously being spearheaded by the National Council of Teachers of Mathematics (NCTM, 1991, 1995, 2000). For example, the Curriculum and Evaluation Standards for School Mathematics document provided the NCTM image of what students should learn in the mathematics classroom. The document details out "what students need to know; how students are to achieve the identified curricular goals; what teachers are to do to help students develop their mathematical knowledge; and the context in which learning and teaching occur…in order to develop mathematical power for all students" (NCTM, 1991:1).

Many mathematics reforms have been conducted over the last half a century or so in an effort to improve mathematics learning. In virtually all cases of reform initiatives they have been conducted in the countries of the developed world such as the United States, the United Kingdom among others. These reforms are focused on improving the quality of mathematics education. For example, according to Wood

(2001:110), “at the heart of the reform effort is a transformation in the ways students learn and teachers teach mathematics” in the United States. Each reform initiative has tried to upgrade the mathematics in schools; to change students’ mathematical experiences; and to advance the student grasp of fundamental mathematical ideas and skills (Ball, Lubienski, & Mewborn, 2001). These reform initiatives have led to many reports and documents that provide practitioners with suggestions and recommendations on the way forward but have led to mixed results.

There have been mixed reactions from the teachers and mathematics educators on the effects of the reform initiatives on practice reported in the United States. On a positive note, Jacobs and Morita (2002:154) have pointed out that “many of these reform efforts encourage teachers to reflect on their instructional techniques, either individually or collaboratively.” On the contrary, there is evidence of little change in mathematics teaching in American classrooms. In fact, according to the TIMSS videotape data, American mathematics teachers still employ traditional practices and seldom apply reform techniques (Stigler, Gonzales, Kawanaka, Knoll, & Serrano (1999). In addition, (Ball et al., 2001) have noted that in spite of reform initiatives the prevalent practices are that “teachers still explain how to do procedures, offer rules of thumb, give tests on definitions and procedures, and provide applications” (Ball, et al., 2001:435).

1.1.1 Student attitudes towards mathematics and achievement in mathematics

The lack of studies that focus on the relationship between attitudes towards mathematics and achievement in mathematics (Ma, 1997) have been a concern for several researchers. However, the few previous research studies have suggested that achievement in mathematics and science in secondary school, in addition to being dependent on teacher practices, “is a function of many interrelated variables: students' ability, attitudes and perceptions, socioeconomic variables, parent and peer influences, school-related variables, and so forth” (Singh, Granville & Dika, 2002: 324). Minato and Kamada (1996) have urgently called for the creation of awareness among teachers about the relationship between achievement and attitudes in Japan. Minato and Kamada posited that increased awareness of the relationship between student attitudes and achievement could facilitate and perhaps enable teachers to improve student learning of mathematics. Ma (1997) has observed that mathematics educators have neglected an exploration of the mutual relationship between attitudes towards mathematics and achievement in mathematics. While many studies have been conducted on attitudes and achievement in other countries, there is lack of studies in Uganda that have specifically explored the two variables in schools. This study hopes to fill this knowledge gap about the nature of students' attitudes towards mathematics and achievement in mathematics.

1.1.2 Teacher practices and student attitudes and achievement in mathematics

Several studies have investigated teachers' work in their schools and classrooms (Fennema, & Franke, 1992; Henke, Chen, Goldman, 1999; Mitchell, Hawkins, Jakwerth, Stancavage, & Dossey, 1999; Mullis, et al., 2000; Wenglinsky, 2002). Nearly all these studies used survey data generated from large-scale studies like TIMSS and the Teacher Follow-up Survey (TFS: 94-95) in the United States.

Gonzales (2000) reported that the TIMSS study was conducted on a broad range of instructional practices. The developers of TIMSS strongly believed that teacher practices could impact on student attitudes and achievement in mathematics.

Various contemporary teaching approaches that could promote the development of positive attitudes and social interaction have also been suggested. For example, Brooks (1990) discussed the constructivist teaching approaches that could increase student involvement in their own learning through active involvement (Vosniadou, 2001). Evans (2002), McCombs (2003b) and Meece (2003) explored the learner centred approaches to instruction. Meanwhile, Slavin (1991) discussed the cooperative learning approach that relies on cooperation rather than competition among learners. These approaches and others reflect how teachers and students could play different roles in enhancing student learning of mathematics which mirror the proposed practices in the vision of the school mathematics teaching by the NCTM that are discussed in section 2.7.

Research evidence suggests that student achievement depends on the manner of teachers' involvement as students work. For example, both individual and small-group activities are most productive when the teacher monitors students as they work - asking questions, providing clues and answers, and offering feedback and explanations (Brophy, 1999; Slavin, 1991; Walberg & Paik, 2000). Class discussions have been shown to be most productive when the teacher actively focuses and guides the conversation, drawing out, contrasting, and challenging student ideas and social participation (Ball, 1991; Vosniadou, 2001).

In sum, the international background shows that a lot of effort has been put to improving mathematics education in the developed world but little is going on in the developing world. The reform initiatives and studies have been conducted using different methods, several theories have been advanced and newer approaches have been suggested. These efforts have had mixed results. However, research consistently shows that student attitudes towards mathematics and achievement in mathematics can be enhanced by teacher practices. Such positive results energise more efforts to study classrooms.

1.1.3 Motivation for the study

In Uganda, educators, parents and the general public are concerned about students' poor performance in mathematics at every level. The Uganda National Council for Science and Technology (UNCST, 1999) observed a relatively high failure rate and poor performance in mathematics at all levels. The UNCST made three claims resulting from the findings of the study among other recommendations. First, the UNCST (1999:33) claimed that there was evidence of "negative attitude toward mathematics as a discipline by both the students and teachers," that seemed to affect the learning of mathematics. Second, the UNCST claimed that the poor performance in mathematics is partly attributed to the poor quality of the mathematics teachers. Third, UNCST claimed that at the time of the study there were no "basics of effective mathematics teaching" (UNCST, 1999:48). The above claims paint a picture of the state of mathematics teachers, teaching and disposition towards mathematics in the country. They portray student outcomes such as achievement in mathematics and student attitudes towards mathematics as unsatisfactory. These claims are however worrying and need to be verified through further research. The blame on teachers suggests that there could be links between teacher practices, student attitudes towards mathematics and achievement in mathematics.

The claims made by the UNCST above raise questions about student attitudes towards mathematics and achievement in mathematics and the nature of teacher practices in their classrooms. There could be many reasons why students perform poorly in mathematics. There is little knowledge about the life in classrooms in Uganda and this needs to be investigated.

The poor performance in mathematics is an unfortunate state of affairs because; it impacts on the academic development of students in science, mathematics and technology. The performance in secondary school mathematics undoubtedly results from a number of other factors such as: school and learning environment, poor background preparation of students at the primary school level, lack or shortage of teaching materials and resources, teachers' classroom teaching practices, crowded classrooms and teachers are confronted with mixed ability classes among others. Furthermore, little attention is paid to the needs of students with poor attitudes towards mathematics and those with learning difficulties. Students with learning difficulties are not identified early either. And the teachers do not have access to the primary school academic background history of the students they teach.

Since the general public continuously asks why some schools perform better than others, they may quite rightly imagine that some students receive better quality education than others. Lack of student motivation seems to be a problem in secondary schools in Uganda. There are a number of students who are highly motivated and do anything that their teachers ask them to do. But there are also a substantial number of poorly motivated students that seems to be growing with the introduction of the Universal Primary Education (UPE) for all primary school going children in the country. The teaching and learning of mathematics in Ugandan schools is therefore in urgent need of improvement.

Educators, policymakers, and researchers take special interest to seek answers to the questions the public raises about schools and students' achievement. At the same time researchers need to provide evidence to either dispel concerns or to provide confirmatory evidence for the concerns about what goes on in schools. The general public is quick to blame the teachers when students produce unsatisfactory results. Whereas the schools employ professional teachers with similar training background differences in student achievement of the students whom they teach still exist. As a result disturbing questions, some of which will be addressed in this study, always cross the mind such as: (1) Are there other confounding factors that do not come to the fore to explain differences on the achievement and attitudes that students develop?; (2) Is the blame on teachers for poor student performance justified?; (3) What is it that teachers actually do with their students in their classrooms?; (4) What do teachers do in different types of schools?

The connection between student attitudes towards mathematics and achievement in mathematics problem solving in particular has not been established, nor has the nature of teacher practices been investigated in Uganda. There has been little research on Ugandan secondary students and on mathematics. Student attitudes towards mathematics and student achievement in mathematics problem solving and their relationships have not been investigated.

The social interaction that goes on in the classrooms could promote or hinder student attitudes towards mathematics and achievement. Teachers and students operate in the social context of the school and the classroom. According to Vosniadou (2001:9) "learning is primarily a social activity and participation in the social life of the school is central for learning to occur." In the classroom much learning and construction of knowledge occur through student social interaction with the teacher and peers. Students working "in small, self-instructing groups can support and increase each other's learning" (Walberg & Paik, 2000:18). So, much of what happens in the classroom depends on the individual teacher's beliefs, conceptions and approaches to teaching. According to Thompson (1992) the approaches to teaching are influenced by the teacher's beliefs and conceptions.

Most studies conducted on teaching and learning mathematics have concentrated on seeking answers to such questions as *what* (content), *why* (rationale) of mathematics; *who* (teacher) teaches, and *who* (student) is taught with *what* (resources), but hardly were there studies on *how* (instructional practice) teaching is done in a descriptive sense. Only a few theoretical studies on how teaching ought to be done exist (Bodin & Capponi, 1996) but more are needed. According to Bodin and Capponi (1996), sound knowledge of teacher dominant practices and the ways any secondary and compounding practices function are prerequisite for improving mathematics teaching. But, in Uganda very often changes that are advocated for in education, especially by politicians, are based on unsubstantiated claims.

The Fennema and Sherman (1976a) contention that it is important to study attitudes towards mathematics in order to improve the teaching of mathematics inspired this study. Furthermore, the study was also driven by Groves and Doig's (1998:17) contention that "knowledge of current practice is a necessary first step in transferring practices developed in research to the wider educational community." The study was also informed by Hatton's (1999:236) argument that "case studies documenting and analysing contemporary school practices need to be built" in order to inform reform initiatives. In addition, whereas there is recognition especially at higher education that teaching is a private business often not discussed, Schwartz and Webb (1993) argue that significant improvement in classrooms might only occur if we scrutinise and analyse what happens in classrooms now. The situation Schwartz and Webb describe in higher education is similar to what prevails in Uganda at lower levels of education.

But, Uganda is one of those countries where educational research, especially in mathematics education is not well developed. There is little or no recent published work on teacher practices. Nor is there anything on how what teachers say and do impact on student outcomes. At least an investigation of mathematics teachers' practices in secondary schools would be necessary as a first step towards improving and strengthening mathematics teacher education in the country. Such a study would provide empirical data as a basis for making decisions on how mathematics teaching and learning could be improved.

The drive for this study originates from other research and what eminent scholars have suggested could be the way forward in order to understand the secret lives of teachers in their classrooms. And in view of the lack of studies on student attitudes towards mathematics and achievement in high performing and low performing schools this study is timely.

1.2 STATEMENT OF THE PROBLEM

The Ugandan education system operates on a national curriculum in every subject. Any curriculum can generally be viewed from three perspectives: the intended curriculum; the implemented curriculum; and the achieved curriculum (Menis, 1991). The system is central in providing the intended curriculum. The teacher is pivotal in executing the implemented curriculum. The student is expected to benefit from the achieved curriculum. The link between the education system, the teacher and the student in mathematics teaching and learning can be viewed as a System-Teacher-Student (SYTEST) model as given in Figure1.1.

The Teacher-Student loop of the model is envisaged to define the teacher practices. The achieved curriculum portrays the students' learning outcomes. These outcomes include acquired understanding of mathematical concepts, the processes and procedures, developed attitudes, work habits and skills and achievement. The Teacher-Student loop of the model is of particular interest in this study as it looks at the teacher input and the student outputs.

As children progress from primary to secondary education the mathematics they do should enable them to develop such mathematical concepts, abilities and skills as: manipulation of numbers, numerical computation, arithmetical reasoning, applications, problem solving and comprehension. However, in reality this does not always happen. This means there is a mismatch between the intended curriculums; the implemented curriculum which portrays the chances that are actually availed to the students to learn the intended material; and the achieved curriculum that shows what the students have actually achieved. Little is known of the way teachers interpret the curriculum for the benefit of their students and the way teachers conduct themselves in the mathematics classrooms.

	Intended	←·······	Implemented	·······→	Achieved	
	↓		↓		↓	
	System	↔	Teacher	↔	Student	
	↓		↓		↓	
	aims		methods/approaches		understanding of:	
	objectives		subject content		concepts, skills	
input →	textbooks		environment		attitudes	→ output
	syllabus content		resources		habits	

Figure1.1: The System-Teacher-Student (SYTEST) Model.

The students who join various secondary schools come from diverse socio-economic backgrounds, different primary school histories, different mathematics achievement with different pass grades, and have different attitudes towards mathematics. One suspects that these students come with weak backgrounds in mathematics, low mathematics self-esteem, high mathematics anxiety, and low interest in the subject matter and generally with poor attitudes towards mathematics. These students find themselves taught by teachers whom they have no choice of and the nature of whose practices they do not know, and may not know. At the end of the secondary school level the students sit national examinations to gain promotion to the next level of education. But, there are disparities in student achievement in the different schools in the country. The parents and the general public usually judge teachers as good if they help students to obtain high achievement.

The general results of the examinations show that the performance of the different schools, examination centres and candidates are varied. There are schools and examination centres that consistently produce "good" results. But there are those whose results are usually poor or unsatisfactory and leave a lot to be desired. There is a general outcry from the parents, the students and the general public about poor achievement in mathematics. The poor achievement of students in school mathematics can be attributed to several factors in the teaching environment such as poor teaching (Mushi, 1992), which is dependant on the teachers. And because the UNCST claimed there was evidence of negative attitude towards mathematics as a discipline by both the students and teachers that seemed to affect the learning of mathematics and poor achievement, which claims merited further investigation.

Classrooms exist within schools and schools are part of the society. Within the classroom the teacher and students operate and live most of their lives. The classroom depends on the available resources, the classroom culture and the teacher practices (Nickson, 1992). The society, taken as the community outside the school, must interact with the school and have a symbiotic relationship with it. The society shares some common elements with the school. The school organisation, culture, effectiveness, location and type are exogenous variables that have been shown to impact teacher practices, the classroom environment and student outcomes, especially attitudes and achievement (Good & Brophy, 1992). The teacher's characteristics, perception, knowledge and beliefs have a bearing on their instructional decisions. The teacher's decisions manifest themselves in the nature of the classroom practices that are thought to affect student attitudes and achievement (Koehler & Grouws, 1992; Fennema & Franke, 1992; Thompson, 1992). The student outcomes, especially their attitudes and achievement may be shaped by their initial beliefs, perceptions and participation either directly from the school or through the classroom and teacher. The student attitudes could directly affect their achievement. Certainly, the level of student achievement in mathematics in the secondary schools in Uganda is below expectations.

1.3 PURPOSE

The purpose of this study was twofold: (1) to investigate the relationship between student attitudes towards mathematics and achievement in mathematics problem solving by school-type and by gender; and (2) to examine the nature of teacher practices in Ugandan secondary schools.

1.4 OBJECTIVES

This study was guided by the following objectives:

1. To establish whether attitudes toward mathematics and achievement in mathematics problem solving are related;
2. To determine student attitudes towards mathematics by school-type and by gender;
3. To determine student achievement in mathematics problem solving by school-type and by gender;
4. To establish what teachers say and do in mathematics classrooms; and
5. To investigate the nature of teacher practices in secondary schools

1.5 RESEARCH QUESTIONS AND HYPOTHESES

1.5.1 Research questions

The following quantitative research questions are dealt with in this study:

1. Are there relationships between student attitudes toward mathematics and achievement in mathematics problem solving?
2. Are there differences in student attitudes towards mathematics (a) by school-type and (b) by gender?
3. Are there differences in student achievement in mathematics problem solving by school-type and by gender?
4. Are there interaction effects between school-type and gender on student attitudes towards mathematics and achievement in problem solving?

The study also seeks to answer the following research questions related to the nature of teacher practices in HP- and LP-schools.

5. What do mathematics teachers do in their classrooms?
6. What do mathematics teachers say about their instructional practices and schools?

1.5.2 Research hypotheses

In seeking answers to the quantitative research questions the following null hypotheses were formulated and tested:

1. There is no significant relationship between student attitudes towards mathematics and achievement in mathematics problem solving;

2. (a) There is no significant difference in attitudes toward mathematics between students from high performing and students from low performing schools;

(b) There is no significant difference in attitudes toward mathematics between male and female students;

3. (a) There is no significant difference in achievement in mathematics problem solving between high performing and low performing schools.

(b) There is no significant difference in achievement in mathematics problem solving between male and female students.

4. There are no significant interactions between school-type, gender and achievement in mathematics problem solving.

1.6 THE RESEARCH SETTING

To get a feel and a picture of where this study took place and for the sake of clarity, this section provides a contextual background for: (1) the study, (2) the secondary schools, (3) the mathematics teachers, and (4) the secondary students in Uganda.

1.6.1 Context for the study

In Ugandan schools mathematics is compulsory at both the primary and the lower secondary education levels. The education system in the country has a pyramidal structure with five levels. First, at the bottom is the nursery education level that lasts two to three years, beginning at age three or four years. Second, is the primary school level that lasts seven years (Primary one (P1) through Primary seven (P7)). Third, is the ordinary (O-level) secondary education level that lasts four years (senior one (S1), through senior four (S4)). Fourth, is the advanced (A-level) secondary education level that lasts two years (senior five (S5) and senior six (S6)). Finally, there is the tertiary and university education level that lasts between two and five years. There are selection examinations to choose students who qualify to move on to the next higher level of education. Every student, parent, teacher and school aspires for student high achievement in these selection examinations.

Although education is not the government's number one priority, government aims at raising the quality of education in the country through improving the standards of student achievement. Government has set up priorities and expressed concerns about education in the country. Because the government realises the importance of education for the social, political, scientific and technological development of the country it attaches due importance to education. The government is equally concerned about students' poor performance in mathematics and science. It is also concerned about mathematics and science teachers and teaching. In this regard it appointed several commissions and engaged in various projects to address some issues of education in the country. One such commission, the Education Policy Review Commission (EPRC), recognised that "no education system can be better than the quality of its teachers…" (Ministry of Education [MoE], 1989:xiii) and recommended that the quality of teachers should be improved but the country remains in a dilemma on where to place priorities.

Another effort by the government, through the Ministry of Education and Sports (MoES), was to evaluate teachers in their classrooms through a monitoring mechanism. The MoES (2001) has proposed an instrument that has to be completed by the school administrators. This instrument is called the 'Teaching and Learning Assessment Instrument for Lesson Observation' (TLAILO). TLAILO is used to gather basic information on the teachers in relation to the basic information that includes: the name of the teacher, the registration number, the qualification, the date of inspection, the name of institution, the type of institution, the subject taught, the class, the duration of the lesson, the total number of students (males and/or females) and the time the lesson took place.

1.6.2 Secondary schools

This study deals with secondary schools in Uganda. There are 2,055 secondary schools in the country (MoES, 2004). There are several similarities and differences between these schools in terms a number of factors. For example, there are similarities in terms of: (1) registration: all schools are registered under the MoES; (2) the curriculum: all schools follow the same national curriculum and students sit the same national examinations at the end of S4; and (3) the primary schools pool: all schools admit students from the primary schools in the country.

However, there are differences between the schools in terms of: (1) the school establishment; (2) the schools' funding; (3) student achievement; (4) the school type: some of the schools are either day or boarding or both; some of the schools are segregated according to students' gender giving rise to either single-sex or mixed schools; (5) the location: some of the schools are urban and others are rural schools; and (6) the minimum admission requirements: some schools take higher grade students and others take lower grade students and consequently determines the nature of the students admitted. Uganda secondary schools usually admit pupils aged 12 years and over.

1.6.3 Mathematics teachers

The majority of the mathematics teachers in secondary schools are qualified professional teachers. Teachers follow different training routes to return to the secondary schools as teachers as illustrated in Figure 1.2. The teachers in the secondary school system include untrained teachers, Grade III teachers from the

Primary Teachers' Colleges (PTCs) who have upgraded to graduate level, Grade V (Diploma in Education holders) teachers from the National Teachers' Colleges (NTCs) and the Graduate teachers from the Tertiary Institutions and Universities. The arrows in the diagram that point from and to the secondary school system indicate the source and terminus of the teachers who teach mathematics at the secondary levels.

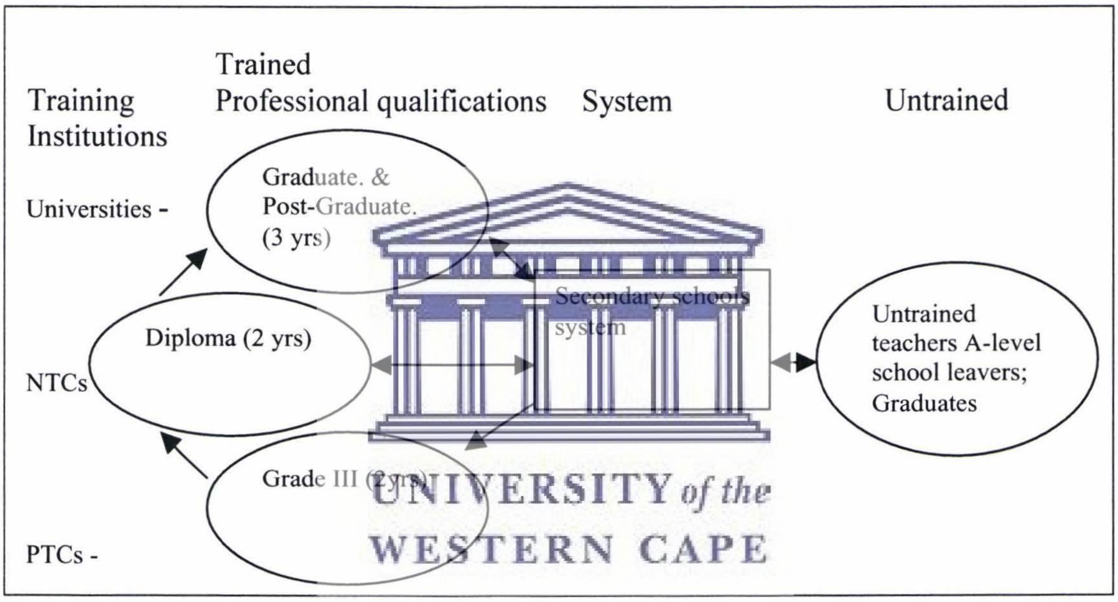

Figure 1.2: Variety of Training Institutions, Professional qualifications and the supply of secondary school mathematics teachers.

The teachers vary in years of teaching experience and gender. Some of the teachers will have just joined the teaching profession while others have over 30 years teaching experience. There are very few teachers of mathematics in the schools and the female teachers are even fewer.

In general teachers are often under pressure to do a good job from the school administration, the parents and the students. Furthermore, the examinations requirements compel the teachers to try to complete the mathematics syllabus. The teachers are expected to make their students pass examinations.

1.6.4 The secondary students

This study deals with secondary school students. There are over 680,000 students in Ugandan secondary schools (MoES, 2004). The ages of those studied range from 12 to 22 years. The students come from families of varying socio-economic backgrounds and begin their secondary education having come from varied primary school academic backgrounds. The students are free to join any secondary school in the country where they qualify to be admitted. Students are enrolled with different primary backgrounds; they have different attitudes towards mathematics and different achievement in mathematics.

1.7 SIGNIFICANCE OF STUDY

Uganda needs to substantially improve the teaching and learning of mathematics in schools. This study might provide information about the relationship between student attitudes towards mathematics and achievement in mathematics problem solving in the Ugandan context. Whereas the relationships between these two variables have been studied elsewhere no such study has been conducted in Ugandan HP- and LP-schools.

Student attitudes towards mathematics of S3 Ugandan secondary students by school-type and by gender and student achievement in mathematics problem solving of S3 Ugandan secondary students by school-type and by gender might be revealed in that area. The results might inform, catalyse and direct appropriately tailored in-service training programmes, seminars, workshops, and educational policies to improve student attitudes and achievement.

Because the nature of mathematics teacher practices has not been extensively studied in Uganda there is a knowledge gap in that area. The study might reveal the nature of teacher practices in the HP- and LP-schools that maybe associated with certain attitudes towards mathematics and achievement in mathematics since the study could provide an eyewitness account of what really goes on in the mathematics classrooms (Robitaille & Travers, 1992). The findings of the study might be an initial step towards identifying teacher current practices as a prerequisite or vehicle towards improving mathematics teaching (Bodin & Capponi, 1996). The knowledge of effective teacher practices that relate to student attitudes towards mathematics and achievement in mathematics problem solving could enable institutional administrators to mount focussed staff professional development programmes in schools and colleges.

This study bears theoretical and practical importance for policy makers; curriculum developers; teacher educators; mathematics teachers; UNEB, the national examining body; school administrators; parents; the general public; and researchers. Policy makers might formulate future policies for improvement of science, mathematics and technology education in the country based on findings. Appropriate decisions could be made for the future based on current situation on the ground that the study revealed. The study might provide other researchers with the starting points to replicate the study at other levels of education. Researchers would be able to extend, to improve and to consider other related variables to this study.

1.8 THESIS OUTLINE

This report includes six chapters and eight appendices. Chapter 1 provides the background, the statement of the problem, the purpose, the objectives, the research questions and hypotheses, the significance of the study and the thesis outline.

The second chapter reviews related literature to the study and gives the conceptual framework of the study. The chapter discusses current research literature on mathematics teaching and learning. In particular, it reviews issues that relate to student attitudes towards mathematics; the teachers' role in students achievement in mathematics; the relationship between attitudes towards- and achievement in mathematics; gender, attitudes towards- and achievement in mathematics; teaching and learning mathematics; teachers instructional practices; the future vision for school mathematics and its teaching; and the conceptual framework for the study.

The third chapter outlines the methodology for the study. It focuses on and spells out the research setting, the research design, the motivation for the quantitative and qualitative approaches used, and the sampling procedure. Furthermore, it discusses and evaluates the pilot study, and provides recommendations for the main study. The chapter also considers and discusses the instruments for the main study; the reliability and validity in quantitative and qualitative research designs; the ethical considerations and issues; the research procedure; and the data analysis.

The fourth chapter reports the descriptive statistics and the quantitative findings of the study from the Student Attitudes towards Mathematics Inventory (SATMI) questionnaire and the Mathematics Problem Solving Test (MPST) by school-type and by gender comparisons. In particular it presents the results on student attitudes towards mathematics and achievement in mathematics problem solving.

The fifth chapter provides and discusses the qualitative findings of the study. In particular it presents the nature of teacher instructional practices related to pursuing excellence and enhancing students' participation in the learning process.

The final chapter provides the discussion of the findings of the study that answer the research questions set out in Chapter 1. This chapter also draws the conclusions and spells out the limitations of the study. The chapter ends with recommendations for suggested further areas of research that could extend this study. The Appendices include more detailed instruments and questionnaires documents, data tables and procedural information on the conduct of the study.

1.9 SUMMARY

This chapter pointed out that there is concern to improve the quality of mathematics education worldwide. At the international level attempts to improve student achievement in mathematics is ongoing through various reform initiatives. Several studies have explored and shown teacher practices, student achievement and attitudes towards mathematics to be linked. But there is lack of empirical data on student attitudes towards mathematics and achievement in mathematics in Uganda.

The system of education in Uganda consists of five educational levels, pre-primary through to tertiary level. The System-Teacher-Student (SYTEST) model shows the linkage between the intensions of the system, the role of the teacher and the position of the students. Whereas the government has put in place a mechanism to monitor teacher performance in their schools, through a lesson observation schedule, the lack of empirical data and knowledge to guide the policy makers' decisions and inform teachers remains a problem to be addressed.

There are differences among schools in terms of their teachers and students and both human and material resources, differences in the types of schools, differences in their ownership and funding, differences in location and so on. These differences could possibly lead some of the schools do perform better than others in the internal and public examinations while others perform unsatisfactorily. The unsatisfactory performance by some of the schools is of great concern to the policy makers, parents, teachers, school administrators and the students themselves.

The research questions and the hypotheses focus on student attitudes and achievement in mathematics together with the nature of teachers' practices in their classrooms. The synopsis of the thesis provides the envisaged content of each of the six chapters in the thesis. The next Chapter reviews the related literature to the study and maps out the conceptual framework for the study.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

This Chapter reviews related literature on the relationships between student attitudes towards mathematics and achievement in mathematics; student attitudes towards mathematics; student achievement in mathematics; gender differences in mathematics; what teachers say and do in classrooms and schools; teacher instructional practices; and the conceptual framework for the study.

2.2 RELATIONSHIPS BETWEEN ATTITUDES TOWARDS MATHEMATICS AND ACHIEVEMENT IN MATHEMATICS

Several studies have examined the relationships between student attitudes towards mathematics and achievement in mathematics (Ma, 1997; Papanastasiou, 2000; Tocci & Engelhard, 1991; Volet, 1997) but with mixed results. For example, achievement and academic performance are reported to depend on a complex and dynamic interaction between cognitive, affective and motivational variables (Volet, 1997). Meanwhile, McLeod (1992) posited that neither attitudes nor achievement is dependent on each other, but they interact with each other in a complex and unpredictable way. In a study in the Dominican Republic Ma (1997) found that (1) a mutual relationship existed between each attitudinal measure and mathematics achievement, (2) the feeling of enjoyment directly affected mathematical achievement but not the feeling of difficulty, (3) the feeling of experienced difficulty acted through the feeling of enjoyment to affect mathematical achievement, and (4) the view of mathematics as essential was free of other attitudinal measures. Ma (1997) recommended that mathematics, especially difficult mathematics content, should be taught in an interesting and attractive manner so that students can enjoy it without feeling that learning mathematics is difficult, even if students with high mathematics achievement do not automatically enjoy mathematics.

Research studies have reported positive relationships between mathematics achievement and the students' attitudes toward mathematics (Maqsud & Khalique, 1991a, b; Papanastasiou, 2000). Using the Third International Mathematics and Science Study (TIMSS) data involving the United States, Japan and Cyprus Papanastasiou (2000:27) concluded that "students who do well in mathematics generally have positive attitudes toward the subject (Mathematics), and those who have positive attitudes tend to perform better." Others studies have found a moderate correlation between attitude and achievement among secondary school students (Maqsud and Khalique, 1991a, b).

Mathematics anxiety is related to prior achievement in mathematics (Hembree, 1990; Ho et al., 2000). According to Hembree (1990) "Mathematics anxiety is related to poor performance on mathematics achievement tests. It relates inversely to positive attitudes toward mathematics and is bound directly to avoidance of the subject (Hembree, 1990:33). When Ho et al. (2000) investigated the affective and cognitive dimensions, the levels and the relationships between mathematics anxiety and mathematics achievement among sixth grade students in China, Taiwan and the United States, among other findings, they found that across the national samples of the three countries, the affective factor of mathematics anxiety was significantly but negatively related to mathematics achievement.

In summary, the studies on the relationship between attitudes towards mathematics and achievement in mathematics show mixed results. Some studies have found a mutual relationship, other studies have found positive relationship and moderate correlation and other studies conclude attitudes and achievement do not depend on each other. There is however evidence that anxiety is significantly but negatively related to achievement.

2.3 STUDENT ATTITUDES TOWARDS MATHEMATICS

From one perspective attitudes towards mathematics could be viewed as an indication of whether one likes, dislikes or is neutral about mathematics. Attitudes consistently have been considered important factors in influencing participation and success in mathematics (Norton & Rennie, 1998). Attitude is a multidimensional construct that is usually taken to include overlapping affective and cognitive components (Ruffell, Mason, & Allen, 1998). It would not be right to assume that attitudes towards mathematics come up exclusively from school experiences and classroom activity.

In recent research affective variables have emerged as leading factors affecting success and perseverance in mathematics and sciences subjects areas (Singh, Granville & Dika, 2002). Furthermore, according to Singh et al. "attitudinal variables such as self-concept, confidence in learning mathematics and science, mathematics or science interest and motivation, and self efficacy have emerged as salient predictors of achievement in mathematics and science" (Singh, et al., 2002:324), though several researchers have espoused that attitudes towards mathematics stem from social forces and the learning environment.

Affective variables are equally as important as cognitive variables in their impact on student learning outcomes (Tocci & Engelhard, 1991). Studies in student attitudes towards mathematics indicate that the size of student attitudes seem to decline as the grade level increases (Mitchell, Hawkins, Jakwerth, Stancavage, & Dossey, 1999). Several studies have examined affective factors related to student attitudes towards mathematics including mathematics anxiety (Bessant, 1995; Engelhard, 1990; Fennema & Sherman, 1976a, b; Hembree, 1990; Ho et al., 2000), confidence, attribution of success and persistence (Vanayan, White, Yuen. & Teper, 1997), motivation (Boekaerts, 2002; Kloosterman & Gorman, 1990; Meece, 2003; Pierce & Kalkman, 2003; Pintrich, 2003), and changes in attitudes (Wilkins & Ma, 2003).

For example, Mitchell, et al., (1999) reported the findings from National Assessment of Educational Progress (NAEP), 1996 mathematics assessment, in United States where student attitudes and beliefs about mathematics at grade 4, 8 and 12 levels were investigated. They noted that the majority of students gave favourable responses to mathematics on statements like: "I like mathematics" but the percentage of the responses diminished as the grade level increased. But, earlier Vanayan, et al., (1997) had surveyed 3rd and 5th grade students' attitudes towards mathematics in a large urban school district in the United States and found that boys and girls were equally likely to indicate that they like mathematics in both grades. However, boys were more likely than girls to report being good at mathematics.

One attitudinal variable that has caught researchers' attention is mathematics anxiety. Mathematics anxiety refers to feelings of "dread, nervousness, and associated bodily symptoms related to doing mathematics" (Fennema & Sherman, 1976a:4). Mathematics anxiety seems to derive from various sources. For example, Tobias (1993) has argued that mathematics anxiety could originate from teaching methods that are conventional and rule bound. However, sometimes researchers have viewed mathematics anxiety as a subject specific indicator of test-anxiety (Hembree, 1990).

Mathematics anxiety has been described as a multidimensional construct with cognitive and affective roots (Bessant, 1995). Students who have negative attitudes tend to have high anxiety about mathematics, they are not confident in what they do in mathematics and they are not motivated to learn mathematics. Students with negative attitudes would probably be scared about doing mathematics and they feel uncomfortable about mathematics and they do not find mathematics enjoyable and stimulating. They probably do not get good grades in mathematics and do as little work in mathematics as possible.

Another attitudinal variable that has been much investigated is motivation. There is research evidence that students come to classrooms with different motivational beliefs and some of them are intrinsically motivated while others are not (Boekaerts, 2002; Pintrich, 2003). Boekaerts (2002) argued that usually students seem to have formed favourable or unfavourable attitudes about a topic before they come to class. But usually students are not motivated to learn in the face of failure and possess unfavourable motivational beliefs that impede learning. Meanwhile favourable motivational beliefs promote learning (Pintrich, 2003). Although students' lack of motivation in mathematics continues to be a problem in many countries of the world, motivation is, however, correlated with achievement and academic performance.

Ho et al. (2000) found that the affective and cognitive factors differed in their association with mathematics achievement. The affective factor was significantly but negatively related to mathematics achievement across the three national samples. The interaction in the different countries (China, Taiwan and the United States) by gender was found to be significant for both the affective and cognitive dimensions of mathematics anxiety. The results of similar studies have shown that students with higher levels of anxiety tend to have lower levels of mathematics performance and achievement (Hambree, 1990).

Meanwhile, Papanastasiou (2000) critically looked at the results of the Third International Mathematics and Science Study [TIMSS] for the US, Japan and Cyprus and pointed out that positive relationships were always noted between achievement in mathematics and the students' attitudes towards mathematics. Based on students' perceptions about the value of mathematics they noted that, "students who do well in mathematics generally have positive attitudes towards the subject, and those who have positive attitudes tend to perform better" (Papanastasiou, 2000:27).

In summary, student attitudes towards mathematics have been linked to student learning. Attitude is a multidimensional construct that involves intersecting cognitive and affective dimensions. But generally attitudes may be positive, negative or neutral. Usually students with positive attitudes towards mathematics demonstrate certain qualities such as intellectual curiosity, confidence, motivation and low anxiety. But, students with negative attitudes demonstrate a dislike for mathematics. Some of the affective dimensions include anxiety and motivation. Students usually come to school with different motivational beliefs that are either favourable or unfavourable to learning. Several approaches have been used for the study of attitudes ranging from surveys to meta-analytic reviews.

2.4 STUDENT ACHIEVEMENT IN MATHEMATICS

One key concern of mathematics education is to produce citizens with the capability to participate in useful discussions and having the ability to make their own decisions in everyday situations. Such development usually takes place in schools through achievement "*created by social groups* to prepare their young for membership in society" (Romberg, 1992) (italics in original). Research studies have concentrated on studying teachers in their classrooms, and yet teachers' roles that are related to student achievement extend beyond the classroom (Schoen, Cebulla, Finn, & Fi, 2003). Schoen et al. (2003:248) contend that "what teachers do outside the class in planning, in supporting students' learning, and in making decisions about how to use the curriculum materials are associated with student achievement but are not directly observable in class." At the same time the study of teachers' work could be drawn from such areas as teachers' views and their descriptions of themselves, the practices they perform in the classroom and in their school environment, the textual materials such as the notes, schemes of work, textbooks and policy documents that they use (Cooper, 1993) including how teachers organise their time.

The way teachers organise their teaching and the amount of time teachers spend on mathematics affects what students learn and the student achievement (Ding & Lehrer, 2002; Hawkins, Stancavage & Dossey, 1998) and how that time was spent in peer groups. For example, in a study of secondary school students in China, Ding and Lehrer (2002) investigated whether and how peer groups affect students' achievement. They found strong evidence that there is a link between peer performance and student achievement and peer effects in China schools. Furthermore, Ding and Lehrer (2002) also noted that all students benefited from three other things: (1) having achieving schoolmates, and (2) having less variation in the quality of the peers in their school, and (3) peer effects operate in a heterogeneous manner. These results led Ding and Lehrer (2002) to conclude that reducing the variation in peer performance increases student achievement. These results have implications for the teachers who group their students through streaming (placing students of similar abilities in the same group) or by randomly mixing students into groups based on some other criteria in their classrooms.

Meanwhile, Papanastasiou (2002) used a structural equation model to investigate the mathematical achievement of eighth-grade students registered in the years 1994-1995 in Cyprus. He looked at family background and academic reinforcement from mothers, from peers and from self as exogenous constructs, and the socio-economic status, the attitudes towards mathematics, the teaching, the school climate and the beliefs related to success in mathematics as endogenous constructs. The study showed that although attitudes, teaching, and beliefs had direct effect on mathematics outcomes, they were not statistically significant.

In sum, the actions that teachers embark upon in helping students to learn depend on the resources and materials that are available to them and their own characteristics such as teaching experience. At the same time the activities that teachers carry out such as grouping of students depend on their perceptions, beliefs and their knowledge of content and the students' background and abilities. The way teachers manage time dictates how much of the intended curriculum gets covered as it is a measure of the opportunity that teachers avail to students to learn.

2.5 GENDER RELATED DIFFERENCES IN MATHEMATICS

Several previous studies have investigated gender differences in mathematics and studies on gender differences continue to dominate the research literature though gender difference is a complex variable to study. However, studies on gender differences in academic achievement and attitudes towards mathematics come up with mixed results. For example, some studies have reported that males outperform females in mathematics achievement (Campbell & Beaudry, 1998; Hedges & Nowell, 1995; Tate, 1997).

Several studies have investigated affective variables that may have contributed to differences in achievement including anxiety (Frost, et al., 1994; Norton & Rennie, 1998), confidence (Drzewiecki, & Westberg, 1997; Meyer, & Koehler, 1990; Norton & Rennie, 1998), motivation (Boekaerts.2002; Meece, 2003; Pintrich, 2003). In a cross sectional survey in which the Fennema-Sherman Mathematics as a Male Domain Scale was used, Norton and Rennie (1998) examined the attitudes of the students in single sex and co-educational secondary schools. The results indicated that (1) there were attitude differences between boys and girls, but girls had a less stereotyped perception of mathematics as a male domain, and (2) there were also differences in the school environment with the girls in the coeducational schools being more stereotyped than the girls in the single sex schools. The results indicated that the girls in the coeducational schools did perceive mathematics as a male domain.

Hyde, Fennema and Lamon (1990) conducted a meta-analysis of 100 studies to assess the conclusion that reviewers often present that males performed better on mathematics tests than females did. Hyde et al., (1990) found that females outperformed males by a small amount. An effect size d = .29 was found in the high school and d = .32 was found in college studies in the problem solving. The overall effect size (d) was d = .15 when all effect sizes were averaged on the samples of the general population. They also found small gender differences in academic performance at the high school and college levels, but no difference at the middle school level. That means the gender differences do not appear until high school. They also found that the magnitude of the gender differences has been reducing over the years.

Some studies have shown that the males top the females in achievement. For example, Hedges and Nowell (1995) studied gender differences in mathematics achievement and found that in general, males outperformed females in mathematics at the time of the study in high school level. In another study involving public school students drawn from the Longitudinal Study of American Youth (LSAY), Campbell and Beaudry (1998) found that high-achieving males scored higher in 11^{th}-grade mathematics than higher-achieving females. In a study of gender differences that focused on seven selected countries Beller and Gafni (1996) found that the only significant differences in mathematics performance were for students aged 9 and 13 years where boys outperformed girls. In addition, the gender effects were substantially larger for science than for mathematics (SD = 0.16 and 0.26 for SDs on the total score in favour of boys).

Earlier, Leder (1992) reviewed literature on gender and mathematics that also covered studies of gender differences in mathematics achievement. She reported that at the primary school level, few consistent gender differences in mathematics achievement exist. But the trend changes at the beginning of the secondary school level males frequently did better than the females on standards mathematics achievement. Leder (1992) posited that gender differences depend on the content, cognitive level of the questions and the format of the test that students do and the age level at which the assessment occurs. Similarly Tate (1997) reviewed quantitative research literature on changes in mathematics achievement of various groups according to race, class, gender, ethnicity, and language proficiency in the United States over a period of 15 years. He found that there was improvement in mathematics achievement in all demographic groups. But among other findings he noted that although males tended to outperform females on standardised measures, gender differences were minimal and generally not significant.

Other studies have reported no significant gender differences between males and females (Alkhateeb, 2001; Bornholt, Goodnow, & Cooney, 1994; & Opyene-Eluk, & Opolot-Okurut, 1995). For example, Alkhateeb (2001) found no significant overall differences in mathematics achievement between males and females in the United Arab Emirates. Opyene-Eluk and Opolot-Okurut (1995) also found that although boys' achievement in mathematics is higher than that of girls in Uganda the difference is not significant. Similarly, Bornholt, Goodnow and Cooney (1994) found no significant difference between male and female high school students in mathematics achievement.

Over the last few years there seems to be a change in the gender gap between the performance of male and female students. For example, the National Centre for Educational Statistics (Perkins, Kleiner, Roey, & Brown, 2004) conducted the 2000-transcript study to investigate the trends of changes in high school curriculum and student course taking patterns for the decade 1990 to 2000 in the United States. The study particularly investigated the course credits that students earned, the grade point averages (GPA) that students got, and the educational achievement of the students. In general, across secondary schools in the United States, from 1990 to 2000, students earned more credits and higher GPAs. In particular, one thing that the study found, among other results, was that there was an increase in course credits earned, in each core subject studied for both sexes, over that period. And in particular, female graduates earned higher mean course credits (26.3), while the males earned smaller mean course credits (26.0) in 2000 and the difference was significant. These course credit means were up from 23.8 and 23.4 for females and males respectively in 1990.

A second thing that the study found out was that, there was a general increase in the mean GPA of high school graduates from 1990 to 2000. In particular, the female high school graduates obtained a higher overall mean GPA (3.05) in 2000, than the male high school graduates (2.83). A third finding was that there was a high positive correlation between the mean GPA earned in mathematics scores of the 2000 high school graduates and the National Assessment of Educational Progress (NAEP) mathematics assessment scores.

In sum, the review indicates that there are mixed results on gender differences in mathematics achievement. In a few cases girls perceive mathematics as a male domain and in other cases there are no significant gender differences. Earlier studies had indicated males were scoring higher than females. Where there are gender differences in achievement they appear to relate to age and the level of the school and sometimes on the type of examination questions set. The gender gap has continuously closed up and now, at least in the United States females are scoring higher grades than males.

2.6 WHAT TEACHERS SAY AND DO IN CLASSROOMS AND SCHOOLS

2.6.1 What do teachers do in their classrooms and schools?

Every teacher desires to facilitate student learning, development positive attitudes and good work habits among students and enable students to succeed with high achievement. There are initiatives to improve student achievement in mathematics (Grouws & Cebulla, 2000; NCTM, 2000). However, teachers vary in the way they play their teaching role in the classrooms and schools. In the majority of cases teachers conduct traditional, expository teacher centred lessons (Bodin & Capponi, 1996) or teacher-centred (Cuban, 2001) teaching methods. Others have used constructivist views of learning and teaching (Brooks, 1990; Jarworski, 1994a, b; Saxe, Gearhart & Seltzer, 1999; Sigurdson, 1992); some have espoused cooperative learning (Ding & Lehrer, 2002; Grouws & Cebulla, 2000; Leikin & Zaskavsky, 1997; Mulryan, 1992, 1994, 1995; Slavin, 1991; Webb & Mastergeorge, 2003); some have used engaged learning (Jarworski, 1994b; National Curriculum Development Centre (NCDC), 2001).

In the process of teaching teachers establish a learning environment where students enthusiastically and effectively engage and participate in learning tasks through classroom teacher-student relationships and interaction (Brekelsmans, Wubbels & Creton, 1990; Leikin & Zaslavsky, 1997; Wubbels, 1993). Previous studies have shown that teachers and students can interact in several ways especially when learning mathematics in small groups. For example, Leikin and Zaslavsky (1997) pointed out five types of interaction patterns between the student, teacher and the learning material: (1) student-student interaction; (2) student-learning material interaction; (3) student-learning material-student interaction; (4) student-teacher interaction; and (5) student-learning material-teacher interaction. The learning-materials refer to anything that is used to enhance the teaching and learning process. The teachers' explanations of worked examples in the classroom promoted learning (Renkel, 2002). Renkel found that the instructional explanations had an effect on student learning.

Very often teachers adapt various teaching approaches in their classrooms. For example, some teachers adhere to constructivist teaching practices (Brooks, 1990). Brooks (1990) listed the practices that teachers who claimed to be constructivist in Shoreham-Wading River School in the United States made part of their teaching repertoire that included: using cognitive terminology such as *classify, analyse, predict* and so on when framing tasks; encouraging students to engage in dialogue; encouraging student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of others.

2.6.2 What do mathematics teachers say they do in their classrooms and schools?

Several studies have reported narratives about how teachers go about their work in classrooms and schools (Watson, 1994). For example, Watson (1994) narrates how she conducts her teaching and her practice that starts off with free engagement activities that emphasise ways of working, telling and showing followed by discussion. Meanwhile, Jaworski (1994a:218) posited that few teachers use this classic way Watson used to introduce whole-class teaching. Such working could be viewed as students in mathematics classrooms being 'mathematicians.' Being mathematicians necessitates "being mathematical within a mathematical community." Jaworski defines 'being mathematical' as a process by which mathematics is actualised (contextualised) or brought to being (mathematisation); and a 'mathematical community' as "a group of people (learners) committed to the sharing and communication of their mathematical thinking" (Jaworski, 1994a: 224). The students are actively engaged and involved. In the process the teacher plays the roles of facilitator, moderator and so on. The backbone of the approach is that the task is clearly described and the students are at liberty to either physically or mentally engage or not engage in the activity and to think.

The stories and findings that are told or reported from research often expose the instructional strategies, the preparation and planning, the materials and resources, the classroom organisation and the assessment and evaluations that are used. For example, according to Pimm and Johnson-Wilder (1999), in conventional mathematics classrooms teachers are expected to explain and the students are expected to remember. Pimm and Johnston-Wilder argued that teaching means, *telling, asking and listening* as a whole-class, or small group, or individually. Teachers talk through exposition and explanations as two forms of telling (Cockcroft, 1982; Flanders, 1970). In a mathematics class the teacher-talk serves at least four functions. First, giving instructions and orientation to the students; second, providing efficient transmission of information; third, focusing a student's attention or making observations of potential significance to the whole class; and finally, encouraging reflection on what has been covered and what could still be covered. Teachers and students therefore see each other in a social context as they work together (Tryphon & Voneche, 1996).

In short, teachers still use traditional expository teaching but there are signs of a gradual move towards more constructivist ways of teaching. Teachers' instructional practices involve teachers' knowledge, planning and preparation, teaching objectives and so on. Teaching is a complex activity that involves several factors. Teachers' conceptions and beliefs determine what they do. Effective teacher practices involve the use of learner-centred teaching, the use of several instructional resources, and the use of assessment to inform teaching, and having more teacher-student interaction. Several ways of teaching such as standards based teaching, cooperative teaching among others, some of which have shown promise, have been proposed to try to improve students' learning of mathematics.

2.7 TEACHER INSTRUCTIONAL PRACTICES

2.7.1 Research on teacher instructional practice

Mathematics teaching is intended to facilitate the learning of mathematics in a conducive-mathematics classroom environment. A mathematics classroom may be envisaged as "an intersection of social and cultural groupings and creeds, driven by political forces and societal demands, and striving to create mathematical discourse that enables students, whatever their personal and social trajectories to learn mathematics" (Jaworski, 2002:38). But, the teachers are under great overwhelming pressure to teach students to pass examinations as they conduct this complex activity.

Teaching is a complex activity that involves many factors. One factor is the teacher. Teacher practices are sometimes taken to be synonymous with teaching style (Tanner & Jones, 1999) and they are given such labels as 'taskers' who are those who emphasise on requirements of activities; 'rigid scaffolders' who are those who love to maintain teacher centeredness and authority in the classroom; 'dynamic scaffolders' who are those who invite student opinion but remain in charge; and 'reflective scaffolders' are those who play the role of moderators in the classroom while the students are actively involved (student centred). In scaffolding students' task engagement teachers provide the students with the necessary assistance to facilitate them to engage in productive learning activities (Brophy, 1999). In the present study teacher practices are taken as the application of teacher judgements about mathematics, about its teaching and about the nature of students that incorporate an appropriate mix of teachers' knowledge of content, pedagogy within and outside the classroom to facilitate students' learning of mathematics.

Tanner and Jones (1999:256) contend, "To be effective a teacher must evaluate the given curriculum and then select or emphasise certain aspects of content, or create materials that will be appropriate within a particular classroom situation." The choice of the content, the instructional approaches and materials are in the hands of the teacher. At the same time, teachers' expectations about what their students are capable of achieving tend to rely on both what teachers attempt to obtain from their students and what the students come to expect from themselves, especially if the teacher establishes and monitors appropriate expectations for the learning outcomes of the students (Brophy, 1999).

According to Lou et at., (1996:423) "contemporary classrooms are notable for the number and diversity of students who occupy them... teachers face students who have a broad spectrum of needs, abilities, goals, and interests and who differ along economic lines." Such characteristics of the classroom environment and students challenge teachers who may require adopting different classroom practices. Also, teachers' personal factors such as knowledge, beliefs, and attitudes are considered as significant factors in determining not only how they teach but also how their students learn.

Research studies have examined teacher classroom practices including grouping practices (Henke et al., 1999), teachers' use of resources and materials for instruction (Haggarty & Pepin, 2002; Grouws & Cebulla, 2000), teachers assessment and evaluation of students practices (NCTM, 1995; Senk, Beckmann & Thompson, 1997); teachers use of technology (Huang & Waxman, 1996). For example, Henke et al., (1999) reported that most of the teachers using reform related practices used different grouping practices at least 86% or more times once in a week. The teachers also used various interaction strategies. Three-quarters of the teachers used models and manipulatives to demonstrate a concept and students used hands-on materials about 80% of the time. Textbook activities were the common activities in the classrooms and as homework. About two-fifths of the teachers reported collecting and correcting homework to base discussion on (45%) or for lesson planning (42%). Henke, et al., (1999) concluded that most teachers used at least one-half of the practices recommended in their subject area. But there are also other factors in play during the teaching and learning process.

According to Haggarty and Pepin (2002:572) when teachers play the role of mediation they "decide which textbook to use; when and where the textbook is to be used; which sections of the book to use; the sequencing of the topics in the textbook; the ways in which pupils engage with the text; the levels and type of teacher intervention between pupil and text; and so on." But, what takes place in the classroom is often influenced, and in some cases determined by the decisions of the education system on the aims, goals and objectives expressed in the curriculum documents, materials and resources.

A substantial amount of research has also focused on studying teachers' work in schools and how their behaviour affects student learning. Several studies in the study of teacher practices have investigated factors that include areas of instruction such as: (1) the roles that teachers and students play in learning activities; (2) the materials and technology used in the classroom; (3) the kinds of tasks that students do both in the classroom and at home; and (4) how teachers assess and evaluate student learning (Henke, Chen & Goldman, 1999:iii); standards-based teaching (McCaffrey et al., 2001; NCTM, 1991, 2000; Riordan & Noyce, 2001; Thompson & Kersaint, 2001; Schoen, et al., 2003); learner-centred teaching (Cuban, 2001; Evans, 2000; McCombs, 2003a; Pierce & Kalkman, 2003).

From the findings of the National Assessment of Educational Education Progress (NAEP), Hawkins et al., (1998) reported that the mathematics teachers who taught mathematics in American schools varied in experience, academic background and qualifications. Some of the teachers may or may not be involved in professional development either. In addition, mathematics instruction received different emphasis in the different schools. However, the majority of the teachers reported getting the instructional materials that they needed for teaching their classes. Furthermore, students have increased access to calculators to do their work. Despite these differences among teachers and in schools the teachers did their best to facilitate student learning.

In the United States, the current vision for school mathematics is that mathematics should be learnt with understanding (NCTM, 2000) through standards based instruction. Standards-based instruction is advocated for and practiced in several States in America such as Massachusetts State (Riordan & Noyce, 2001), Florida State (Thompson & Kersaint, 2001). One principle discussed by the NCTM is the teaching principle. The teaching principle states that "effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (NCTM, 2000:16).

Standards-based instruction refers to the process of using *Standards* to guide teaching. This type of teaching involves being clear about three things: the standards, the benchmarks, and the indicators. (1) The *standards* are "descriptions of what mathematics instruction should enable students to know and do" (NCTM, 2000:29) and include: (a) Five content standards for Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability and (b) Five Process standards including Problem Solving, Reasoning and Proof, Communication, Connections and Representation. (2) The *benchmarks* are statements of what a student should know and be able to do at a specific point in time in his of her schooling. (3) The *indicators* are the statements of knowledge or skills that a student demonstrates so as to satisfy the benchmarks (NCTM, 2000). The NCTM advises teachers to apply a variety of techniques and instructional strategies in their instructional practices in the classrooms and schools. The strategies to be applied should benefit all students irrespective of their type, ability and gender or race. However, it is worth noting that classrooms in which the same standards-based curriculum and teaching practices are used may be different.

The NCTM (1991) proposed curricular reform to be accompanied by five major shifts in the nature of classroom instruction to which teachers:

1. View classrooms as mathematical communities rather than a collection of individuals;

2. Use logic and mathematical evidence to verify results rather than relying on the teacher as the authority;
3. Emphasise mathematical reasoning rather than memorising procedures;
4. Focus on conjectures, inventing, and problem solving rather than mathematical answer finding; and
5. Make connections among the ideas and applications of mathematics rather than seeing them as isolated concepts and procedures.

Another approach to teaching that has received prominence in current literature is learner-centred teaching. Learner-centred teaching is based on the assumption that an open and flexible environment is necessary for enhancing students' intrinsic motivation to learn. The learner-focused approach tries to promote the students' enjoyment of school, class participation, independent development of self-concept, career development, and multiple talent experiences including a democratic classroom control. In such a classroom student individual differences and their unique learning styles are recognised. Furthermore, students are given opportunity to interact with their peers, they are enabled to discover their strengths and weaknesses and are facilitated to ascertain what match their needs and learning styles (Evans, 2002; McCombs, 2003b; Meece, 2003). According to Meece, learner-centred practices involve: (1) a movement towards a constructivist and authentic approach to teaching; (2) a focus on conceptual understanding, problem solving and reasoning; (3) an emphasis on student improvement and learning for its own sake; (4) a collaborative learning and decision making process; and (5) a classroom environment that honours and respects students' voices. (Meece, 2003:113-114).

In addition, McCombs (2003b) provided a list of characteristic ways that teacher-centred teachers conduct themselves that include understanding not only that learning is a life-long process but also that motivation to learn comes naturally when the learning context is supportive; knowing that all students are learners who want to learn, so as to make sense of the world around them; encouraging students to talk about how they would meet their learning needs, satisfy their natural curiosity and make sense of things.

Furthermore, research on instructional practices has revealed various factors those affect teacher practices. For example, research in teaching and learning mathematics over the last 40 years or so has shown that teachers' instructional practices are significantly shaped by their conceptions (Thompson, 1992); beliefs (Groves & Doig, 1998; Leung, 1995; Thompson, 1992); knowledge (Ball, 1991; Ernest, 1989; Fennema & Franke, 1992); culture (Nickson, 1992); teacher expectations (Jussim, Smith, Madon & Palumbo, 1998); and teacher efficacy, especially teacher characteristics and workplace antecedents (Ross, 1998). Jussim et al., (1998:38) argue that "high teacher expectation can increase students' achievement and unduly low expectations can undermine students' achievement." Teacher expectations satisfy the self-fulfilling prophecy. Self-fulfilling prophecy happen when false beliefs lead to their own fulfilment.

Teachers' conception of teaching is influenced by their views on the way students learn and by the cultural expectations of the teachers (Evans, 2002). According to Evans, teachers' conceptions of students' learning presumes that all students learn in the same way and so teachers often should use the same teaching methods to convey knowledge to all students. But, other conceptions of learning put emphasis on students' engagements in activities that are thought to lead to real understanding, meaningful learning of ideas or opportunities to construct their own understanding of phenomena. These conceptions echo the view of student-centeredness. Evans (2002) pointed out that a child-centred curriculum and the theory of constructivism have fundamental propositions for teaching, for the role of the teacher and for the design and conduct in the classroom.

2.7.2 Resources for mathematics instruction

There has been advocacy for the use of instructional materials and resources to facilitate the teaching and learning processes. The teaching resources range from physical objects to computer software. There has been a substantial increase in the use of technology (calculators and computers) in the teaching of mathematics and science. The mathematics instructional resources and materials include printed materials like textbooks, scientific calculators and computers, hands-on manipulatives, models and visual aids. Common experience has shown that several teaching resources can be used to illustrate, clarify certain concepts; enhance the demystification of abstract concepts to concrete terms and the application of materials to practical mathematics.

Grouws and Cebulla (2000) have argued that "in general, research has shown that the use of calculators change the content, methods, and skills requirements in mathematics classrooms" (Grouws & Cebulla, 2000:30) as did Dion, et, al., (2001). They further argued that attentive use of calculators in mathematics classes advances student achievement and attitudes towards mathematics, because the opportunity to learn mathematics content that students experience directly impacts on their achievement.

Mathematics teaching and learning can greatly be enhanced through the use of teaching-learning materials and manipulatives. Teachers, for example, usually rely on textbooks to organise lessons and structure the subject matter (Haggarty & Pepin, 2002; Ottevanger, Leliveld, & Clegg, 2003). There is much support that calculators should be an integral part of the mathematics curriculum among mathematics educators and calculators use in classrooms and schools are gradually becoming more common (Dion et al., 2001). For example, Haggarty and Pepin (2002) examined the way teachers in lower secondary mathematics classrooms used textbooks in France, England and Germany. They found that there are differences in the three countries in how mathematics teachers used the content in textbooks, the way that mathematics was made available to learners or the opportunities that learners were given to learn mathematics, and how learners were able to access textbooks. Huang and Waxman (1996) conducted a study that showed that technology was not widely used in schools, even in a developed country like the United States.

2.7.3 Assessment and evaluation of student learning

Teaching and assessment are intertwined activities in classrooms (Cockcroft, 1982; NCTM, 1995, 2000). Assessment is therefore part and parcel of teachers' recipe for teaching. Mathematics assessment involves the actions that teachers conduct to evaluate student learning and possibly their own teaching. In most cases students' work is judged through summative assessment. However, the NCTM stated that "assessment is the process of gathering evidence about a student's knowledge of, ability to use, and disposition toward, mathematics and of making inferences from that evidence for a variety of purposes" (NCTM, 1995). Whereas assessments are usually "geared to measuring and recording the pupil's progress in relation to the aims and objectives [of the curriculum]" DES (1987:45) those aims are not always achieved in practice.

Assessment serves several purposes. For instance, according to the NCTM "assessment should support the learning of important mathematics and furnish useful information to both the teachers and students" (NCTM, 2000:22). But, above all "assessment is a valuable tool for making instructional decisions (NCTM, 2000:23). The shift is therefore towards formative assessment of students' work that may help with the teaching process. The Department of Education and Science (1987:47) has argued that "it is essential that assessment should reflect broad classroom approaches to the teaching and learning of mathematics, and provide a positive stimulus to their future development." As such "assessment procedures should include a variety of approaches" (DES, 1987:49).

Several research studies have investigated teachers' assessment practices in their classrooms. For example, Senk, Beckmann and Thompson (1997) conducted a study in 19 mathematics classes in five high schools to document high school mathematics teachers' assessment practices and to understand teachers' perspectives as they assess their students' performance and translate the results of their assessments into grades. Senk et al. followed the 1995-NCTM assessment standards for school mathematics in the United States (NCTM, 1995). Their results showed that most teachers use tests and quizzes to determine about 77% of students' grades. The test items used were usually of low-level cognitive demand. They also found that some new recommended reform-based forms of assessment were being used in some of the classes but not in others. They concluded that the teachers' knowledge and beliefs, the content and textbooks for the course combined to influence the characteristics of the test items and assessment instruments that were used in classrooms.

2.8 THE CONCEPTUAL FRAMEWORK FOR THE STUDY

The conceptual framework shown in Figure 2.1 constructed by the researcher derived from the literature review defines the general factors that are conceptualised to contribute to student learning outcomes in mathematics. The factors include the inputs, the school, the classroom, the teacher, the students and the outcomes (student attitude and achievement). In the framework the first factor is conceptualised the inputs. The inputs refer to variables that are associated with the curriculum, the resources and materials. The resources constitute the supplementary instructional materials that are supplied by the system and include the intended curriculum to help in the teaching and learning of mathematics. The second factor is the school. The features within the school include the school-type, the location and the environment of the school, and the school culture. The school contributes to what the teacher is able to and not able to do and could determine what may happen in the classroom.

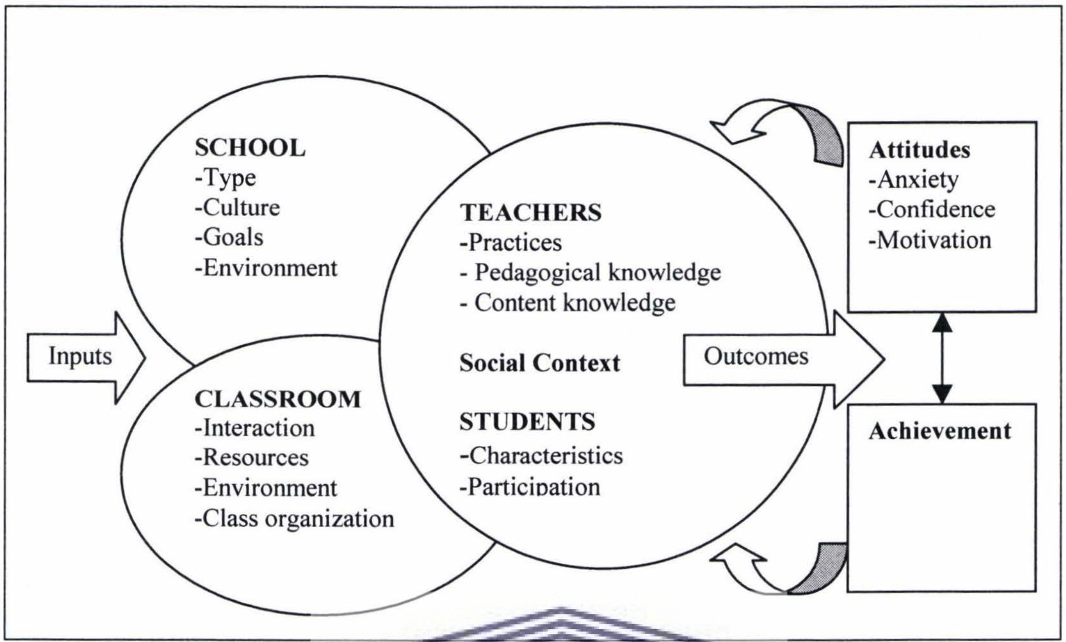

Figure 2.1: Relationships among the Inputs, School, the Classroom, the Teacher and Student Outcomes That Determine Mathematics Teaching and Learning Trajectory

The third factor is the classroom. The classroom has its own social environment but includes the resources, the organisation of the class and interactions. The school, the teacher and the students shape the interactions in the classroom.

The fourth factor is the teacher in the social context. The teacher and the students determine the social context of the classroom. Teachers and students operate in a social context of the school and the classroom. In the classroom much student learning and construction of knowledge occurs through social interactions with the teacher and peers. What happens in the classroom depends on individual teacher's approach to teaching, because the approaches to teaching that are used are influenced by the teacher's beliefs and conceptions (Thompson, 1992). The model depicts a possible relationship between the student outcomes (attitudes and achievement) and associated teacher practices. However, other confounding variables such as the social teaching norms and the school and the classroom-teaching environment could affect the relationship. Thus, student outcomes are explored in this study then followed by an investigation of the nature of teacher practices.

The features also include teachers' expectations from the students, the school and the classroom. For instance, the way the teacher interprets the intended curriculum for the benefit of his or her students is determined by the teacher's knowledge, and one's repertoire of the teaching approaches and expectations. Meanwhile the student-features include their characteristics and their participation in the teaching learning process. The students' component includes the students' characteristics within the school and classroom; their engagement and participation in the learning activities. The framework suggests that teacher practices are shaped by teacher beliefs, conceptions and knowledge of and about mathematics. Furthermore, it suggests that students' outcomes include attitudes towards and achievement in mathematics and that there may be a two-way relationship between attitudes towards mathematics and achievement in problem solving (Hembree, 1990; Ma, 1997).

The fifth dimension is the student outcomes. The outcome features serve as a manifestation of the achieved curriculum. Students' attitudes toward mathematics show their affective outcome. The attitudes towards mathematics are manifested in the levels of anxiety, confidence and motivation in relation to mathematics that the student shows. These outcomes, attitudes and achievement feed back to the social context of the classroom where the teachers and students operate. The students' achievement in mathematics problem solving indicates their cognitive outcome. For instance, the students may develop good work habits and be interested in mathematics, they are motivated to mathematics and they are not anxious about mathematics. At the same time students could have high achievement in mathematics to the pleasure of the parents, the teachers and the general public. One goal of this study was to examine the relationship between attitudes towards mathematics and achievement in mathematics problem solving.

In brief, the model provides a framework in which to address the following research questions: (a) What attitudes towards mathematics do secondary school students have? (2) What is the secondary student achievement in mathematics problem solving? (3) Are there relationships between attitudes towards mathematics and achievement in problem solving? (4) How do secondary teachers teach mathematics and are their instructional practices related to the student outcomes?

2.9 SUMMARY

This chapter reviewed the literature that informed this study which is related to student attitudes towards mathematics, achievement in mathematics and teacher practices. It was noted that attitudes towards mathematics influenced student participation and success in mathematics. Students could develop or posses positive or negative attitudes towards mathematics. Students who developed positive attitudes tend to exhibit certain qualities like low anxiety, feel more confident and are more motivated to do mathematics and often perform well in mathematics. Students who have negative attitudes towards mathematics tend not to do well in mathematics. It looked at several studies that investigated student attitudes towards mathematics and achievement with varied results. But, it noted that teachers played key roles in students' development of attitudes towards and achievement in mathematics.

Gender differences in mathematics attitudes towards mathematics and achievement in mathematics problem solving have sometimes indicated small differences in favour of males but that are not statistically significant. However, the gender differences gap is closing.

There are currently several views about teaching and learning such as constructivism, cooperative learning and engaged learning among others that attract mathematics educators' attention. Teachers' instructional practices within the complex classroom environment are approached variously. The dominant school of thought is about standards-based teaching, learner-centred teaching among others.

These practices make use of several supplementary instructional materials and resources. The new suggested teaching approaches come with new approaches to assessing and evaluating students learning. In classrooms teachers interact with their students in different ways. Certain interaction patterns promote student learning of mathematics. Teachers with long teaching experience have ways of teaching that have proved successful to promote student learning. The next chapter discusses the research methodology of the study.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the methodology used for this study. It focuses on the research design; the motivation for the quantitative and qualitative approaches; the sampling procedure; the pilot study; the evaluation of the pilot study; the recommendations for the main study; the instruments for the main study; reliability and validity in quantitative research; reliability and validity in qualitative research; ethical issues and considerations; the research procedure; and the data analysis procedures.

3.1.1 Elaborating research questions

As stated earlier in section 1.3 the purpose of this study was to investigate student attitudes toward and achievement in mathematics problem solving and the nature of teacher practices in Ugandan secondary schools. The study sought to answer the following six questions:

1. Are there relationships between student attitudes towards mathematics and achievement in mathematics problem solving?
2. Are there differences in student attitudes towards mathematics (a) by school-type and (b) by gender?
3. Are there differences in student achievement in mathematics problem solving (a) by school-type and (b) by gender?

4. Are there interaction effects between school-type and gender on student attitudes towards mathematics and achievement in mathematics problem solving?
5. What do mathematics teachers in HP- and LP-schools do in their classrooms?
6. What do mathematics teachers in HP- and LP-schools say about their instructional practices and schools?

3.2 RESEARCH DESIGN

This study employed both quantitative and qualitative research methods. The study combined a survey of student attitudes towards mathematics and achievement in mathematics problem solving with observations of lessons and interviews with the teachers to investigate teacher practices. The combined approach allowed the researcher to try to understand the meanings that teachers held about their daily actions and to dig deeper into what they practiced.

3.3 MOTIVATION FOR QUANTITATIVE AND QUALITATIVE APPROACHES

It has been argued that the choice of quantitative or qualitative methods for any study depends on the purpose of and research questions of the study. Quantitative and qualitative or naturalistic field researches are research methods used in different ways, but they complement each other in several ways (Guba & Lincoln, 1981). The advantage of using both quantitative and qualitative methods is that they enhance the gathering of rich data. However, quantitative and qualitative research methods have rather unique distinguishing characteristics. For example, Miles and Hurberman

(1994) listed recurring characteristics given below to illustrate naturalistic research. The following four characteristics of naturalistic research were found related, suitable and were adapted as the approach for this study, which strictly speaking is not naturalistic.

According to Miles and Hurberman (1994: 5-7) in naturalistic research:

1. The researcher attempts to capture data on the perceptions of local actors "from the inside", through a process of deep attentiveness, of empathetic understanding (Verstehen), and of suspending or "bracketing" preconceptions about the topics under discussion.

2. Reading through these materials, the researcher may isolate certain themes and expressions that can be reviewed with informants, but that should be maintained in their original forms throughout the study.

3. A main task is to explicate the ways people in particular settings come to understand, account for, take action, and otherwise manage their day-to-day situations.

4. Most analysis is done with words. The words can be assembled, sub-clustered, broken into semiotic segments. They can be organized to permit the researcher to contrast, compare, analyze, and bestow patterns upon them.

At the same time, qualitative information collection methods include observation and interviewing. In observation methods the researcher systematically watches, listens to and records events, behaviours, phenomena of interest in the social setting chosen for the study (Marshall & Rossman, 1995). One objective of this study was to qualitatively investigate what teachers do in their mathematics classrooms. By observing the actual behaviour of individuals in their natural setting one may gain a much deeper and richer understanding of such behaviour (Strydom, 2001b). A suitable agenda for studying classrooms involves therefore observation and talking to teachers to articulate the meanings of their actions through interviews. Observing teachers teaching and talking to them were the approaches that were used in this study.

Patton (1990) clearly articulated the circumstances under which interviews are suitable saying:

> We interview people to find out from them those things we cannot directly observe…we cannot observe feelings, thoughts, and intentions. We cannot observe behaviours that took place at some previous point in time. We cannot observe situations that preclude the presence of an observer. We cannot observe how people have organised the world and the meanings they attach to what goes on in the world. We have to ask people questions about those things. The purpose of interviewing, then, is to allow us to enter into the other person's perspective. (Patton, 1990:196).

The considerations raised by Patton require a qualitative or naturalistic approach to the study of classroom phenomena as was the case in this study. On the other hand, quantitative techniques provide information to such questions as, *'who?', 'what is?', 'when?'*, and *'where'?* in numerical form. Although figures and numbers provide quantitative information that is useful, they do not always provide adequate explanations. In particular, figures and numbers do not provide answers to the questions about '*how?', 'what?' and 'why?'* certain things happen the way they do (Neuman, 2000). In this study the collected questionnaire data and test results were suitable for quantitative analysis.

Based on the usefulness of the qualitative methodology outlined above the motivation to use the qualitative approach therefore derives from an urge to obtain an eyewitness account of what is going on in classrooms. At the same time the approach availed an opportunity to ask *what, why, and how* questions about the actions teachers take. It also enabled an investigation of the possible implications of such actions on students' learning and enjoyment of mathematics. At the same time, because of the knowledge that student attitudes towards mathematics and achievement in mathematics problem solving beg *what is, when, where and who* questions that are suitable to be captured through quantitative methods, a quantitative approach was also used in this part of the study.

3.4 SAMPLING PROCEDURE

For the purpose of this study the teacher-target population was the secondary mathematics teachers and the student-target population was the ordinary O-level mathematics students. The Uganda Certificate of Education (UCE) national mathematics examinations results of schools for the years 1998 and 1999 were obtained, with permission from the Uganda National Examinations Board (UNEB). The year 2000 results were not yet available at the time of data collection. The secondary schools in the country were ranked based on the mathematics average mark of the candidates in each school over the two years. The national average marks for the schools ranged from 2.4% to 57.4%. The schools were then divided into three groups: (1) schools whose average fell in the bottom 27% of the range; (2) schools whose average fell in the middle 46% of the range; and (3) schools whose average fell in the top 27% of the range. The twenty-seven percent cut-off value was chosen because it "provide[d] the best compromise between two desirable but inconsistent aims: (1) to make the extreme groups as large as possible and (2) to make the extreme groups as different as possible" (Ebel, 1979:260). The schools in the bottom 27%-group were categorised as low-performing (LP) and the schools in the top 27%-group were categorised as high-performing (HP). The schools that were identified as either HP- or LP-school were located and requested to participate in the study. Schools that were geographically located in three districts of central Uganda were eventually used for the study.

3.4.1 Sample and participants

This section gives the details of the schools', the teachers', and the students' samples.

Schools

Ten secondary schools that met the selection criteria stated above were selected for the quantitative part of the study as follows. The secondary schools identified as high performing or low performing in the three districts were given a code number. Five HP-schools and five LP-schools were then randomly selected from the code numbers. However, one LP-school could not be located so only four LP-schools were used. Therefore, a total of nine schools were used for the study. The schools that were selected had different characteristics. For example, the HP-schools were one boarding girls-only school, one boarding boys-only school, one mixed boarding school, and two mixed day schools. While the LP-schools were three mixed day and boarding schools and one mixed day school. In the qualitative part of the study four schools from the nine used (two HP-schools and two LP-schools), were randomly selected and used. The selected HP-schools were given pseudonyms as HP1 and HP2. The LP-schools were also given pseudonyms as LP1 and LP2. The pseudonyms were used to conceal identity of the institutions and the participants to conform to the ethical issues and considerations of the research process as discussed further in section 3.11.

Teachers

A small purposeful and theoretical (Merriam, 1998; Patton, 1990) sample of four teachers (two from HP-schools and two from LP-schools) was selected for the qualitative part of the study. All the teachers were male due to the random selection process and the negligible number of female mathematics teachers in the schools. For the purpose of this study, the four teachers were given corresponding pseudonyms T1 and T2 in the HP-schools, and T3 and T4 in the LP-schools. The selection of the teachers was based on that: (1) the teacher was a professional and qualified to teach mathematics; (2) the teacher had over three years of teaching experience; (3) the teacher taught the S3 student sample class in the school; and (4) the teacher was willing to participate in the study.

Teacher T1 was a BSc. Ed graduate teacher with mathematics as a major subject. He taught mathematics to S.2 and S.3 classes, as well as Physics to O-level classes. T1 taught at HP1 and he had six years teaching experience. Teacher T2 was also a BSc. Ed graduate teacher with mathematics as a major subject. He taught mathematics to S.2 and S.3 classes, as well as Physics to O-level classes. T2 taught at HP2 and he too had six years teaching experience. Teacher T3 was a B. Ed graduate teacher. He first trained as a grade V teacher at a National Teachers' College and later enrolled at a university and qualified as a university graduate teacher with mathematics as one teaching subject. He taught mathematics to S1, S3 and S4 classes. T3 taught at LP1 and he was the head of the Mathematics department at LP1 and he had sixteen years teaching experience. Teacher T4 was a B. Ed graduate teacher. He initially qualified at a National Teachers' College as a grade V teacher and later as a university graduate teacher with mathematics as one of his teaching subject. He taught mathematics to S.3 and S.4 classes, as well as Physical Education to lower classes. T4 taught at LP2 and he was the head of the mathematics department at LP2. He had seventeen years teaching experience.

Students

In each school up to 40 students from one senior three (S.3 or grade 9) class, (not the whole class), were randomly selected from the class lists to participate in the study. A total of 279 students completed the Student Attitude toward Mathematics Inventory (SATMI) questionnaire. Of these 254 students sat the Mathematics Problem Solving Test (MPST), which indicated a return rate of over 90%. The data for the 254 students were analysed for the main study.

3.5 PILOT STUDY

3.5.1 Purpose and sample

Purpose

A pilot study which refers to "a small study conducted prior to a larger piece of research to determine whether the methodology, sampling, instruments and analysis are adequate and appropriate" (Bless & Higson-Smith, 2000:155) was conducted in the first term of the 2001-school-year for the following reasons: (1) to determine the clarity of the questions and the instructions of the research instruments; (2) to try the instruments' administration procedures; (3) to test if the instrument could be used; test the workability of the research design in a field setting; and isolate design problems and weaknesses so as to rectify problems or apply necessary corrective measures before the main study; (4) to collect data to establish the reliability of the instruments with a view of improving their quality and sensitivity; and determining the time period necessary to complete the instruments; and (5) to test the research hypotheses and answer the research questions of the study using a smaller but identical sample to the sample to be used in the main study. The use of a similar sample conforms to Bell's (1996) recommendation that a pilot study ought to be conducted on a group that is similar to the one that will form the population of a main study.

Sampling

The sampling procedure for the pilot study was the same as the one described earlier in section 3.4 for the main study. A small and identical sample to the main study sample was used for the pilot study.

Participants

The schools

A purposive sample of four schools, two HP- and two LP-schools from a district in eastern Uganda was selected for the pilot study. The schools generally had students of low-medium socioeconomic status. The HP-schools were both single sex (one for boys and the other for girls) boarding schools. The LP-schools were both mixed-sex day schools. One LP-school was and both HP-schools were urban. The other LP-school was rural.

The teachers

Seven mathematics teachers were requested to participate in the study (two teachers from each participating school, except in one LP-school where there was only one mathematics teacher). The teachers willingly accepted to participate in the study. There were six male teachers and one female teacher. The teachers' teaching experience ranged from two to 18 years. Only one male and one female teacher (one from HP-school and the other from an LP-school) were randomly selected for the qualitative part of the study.

Students

A random sample of ten S3 students from each participating school was selected for the pilot study. A total of 40 students participated in the study. There were 24 males and 16 female students aged between 12 and 21 years with a mean age of 16.1 years.

3.5.2 Instruments, procedure and analysis

Instruments

The data were collected using five instruments: a Student Attitude toward Mathematics Inventory (SATMI); Mathematics Problem Solving Test (MPST); a Lesson Observation Protocol (LOP), a Teacher Practices Inventory (TPI) and a Teacher Interview Guide (TIG).

Procedure

The procedure of administration of instruments for the pilot study was similar to that of the main study as detailed out later in section 3.10. Similarly the ethical considerations taken were similar to those of the main study detailed out in section 3.9.

Analysis of the pilot data

The analysis of the pilot data followed the same procedures using descriptive statistics, two-tailed t-test, univariate ANOVA, and Pearson correlation analysis similar to the analysis of the main study described later in section 3.11 for the SATMI, MPST, LOP, TIG instruments. However, the Statistical Package for Social

Sciences (SPSS) Version 10.0 for Windows (SPSS Inc., Chicago, IL, U.S.A.) was used at this stage.

The teacher practices inventory

The open-ended question in the TPI was qualitatively analysed. The data was coded, categorised and themes identified as the teacher's practice. The analysis of the teacher styles was attempted statistically using SPSS Version 10.0 for Windows but it proved difficult to categorise and analyse and was left out of further analysis and use.

3.5.3 Evaluation of the pilot study

The pilot study provided the necessary experience in the field for the researcher. The pilot was conducted in a district far away from the main study districts so minimise the chances of students who would possibly participate in the main study seeing the MPST problems before they are administered thus avoiding a possible leakage of the questions.

The original Student Attitudes towards Mathematics Inventory (SATMI) contained five sections. These scales were made up of items modified from the Mathematics Attitude Inventory (MAI) (Welch, 1972) and the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976a, b). The students were asked to express the extent of their agreement with the given statements on a four point Likert scale. Each section had some open ended questions and relevant related probe questions. For example, section A was on personal information and had five items related to the student gender, age, mathematics grade obtained at the Primary Leaving Examination (PLE) and the parents' highest educational level. Section B was on student attitudes towards mathematics which had 21 items (seven items on anxiety, eight items on confidence and six items on motivation). For this part of the questionnaire a four point Likert scale ranging from 1 = Strongly Disagree to 4 = Strongly Agree was used. An example of an open ended question in this section was: (1) Do you feel anxious about mathematics? The response required a Yes/No answer. It was then followed by the questions (a) If yes, Why?... (b) If No, then answer the following questions… (The questions that followed were related to anxiety); (2) Do you feel confident about your mathematics? Yes/No (a) If Yes, answer questions… that followed on confidence in mathematics. (b) If No, Why not?....

Section C was on Constructivist Learning Environment Survey (CLES) and had 18 items. The items asked students to describe their opinion about aspects of the mathematics classroom they were attending right then. A four point Likert scale ranging from 1 = Almost Never to 4 = Almost Always was used. Section D was a Questionnaire on Teacher Interactions (QTI) and had 18 items. The instrument asked the students to express their opinion about the behaviour of the teacher. A four point Likert scale ranging from 1 = Never to 4 = Always was used. An example of the related open question was: Does your teacher assist you with your work? Yes/No, (a) If Yes, answer questions…that follow. (b) If not, Why not?...

Section E was on Classroom Environment Instrument (CEI) and had 30 items. The questionnaire contained statements about practices that could take place in class. The students were asked to respond how often each practice took place in the classroom. A four point Likert scale ranging from 1 = Almost Never to 4 = Almost Always was used. A typical open-ended question was: Do students in your class cooperate with one another? Yes/No. (a) If Yes, answer questions that follow related to the item… (b) If No, Why not?…

The original Mathematics Problem Solving Test (MPST) had four questions selected from a pool of eight questions. The questions included were from the content expected to have been covered by the students at the S3 level. The MPST instrument contained four open-ended problems. Basically open-ended problems were tasks that met the following criteria: (1) the content was readily identifiable by the student; (2) the questions were non-routine, that is, not of the type of problems found in conventional textbooks or class-work exercises, and (3) the students had been exposed to the concepts and skills necessary for their solution (Stillman & Galbraith, 1998). The instrument was intended to measure students' performance on ability to solve mathematics problems. The MPST was developed by the researcher from an initial pool of eight problems that met criteria, similar to the criteria used by Stillman and Galbraith (1998).

The problems required students to apply prior mathematical knowledge to the new problem situations. The students spent between 20 and 90 minutes to complete the test. One of the problems stemmed from and was based on the investigation "the handshake problem" (NCTM, 1989). An example of a problem in the MPST as used in the pilot study was:

Problem. Anthony, a senior three student, is the school sports prefect who has to plan a football tournament involving ten schoolhouse teams. The prefect is not quite sure of how to find the total number of games to be played, if each house-team plays each other house-team once. Please help the prefect to find the total number of games to be played and how you worked it out.

The full text of the MPST test is given in Appendix B1 together with its marking guide in Appendix B2.

The Lesson Observation Protocol (LOP) was an open procedure used to record the events in the classroom. Its structure consisted of the lesson timing, development, teacher and student activities and general comments. The LOP was meant to capture what transpired and was happening in the classroom as witnessed by the observers. The LOP was completed during lesson observation and the general comments section completed during and immediately after the observation. The lesson observation was followed by face-to-face interviews with each teacher observed.

3.5.4 Recommendations for the main study

Following from the pilot study it became clear that some corrective measures were necessary to improve the quality of the instruments and the study. The following adjustments were then found necessary:

1. The SATMI instrument was to be re-worked and rewritten with shorter and clearer instructions. Its response format was to be changed from a 4-point

Likert scale a format adapted from the Mathematics Attitudes Inventory (Welch, 1972) to a 5-point Likert scale so as to conform to the original Fennema-Sherman response format. The qualifiers for the responses used Strongly Disagree (SD); Disagree (D); Undecided (U); Agree (A); and Strongly Agree (SA) instead of the numbering system. The SATMI instrument was to be finally a modification of the Fennema-Sherman Mathematics Attitudinal Scales only. The instrument was to be improved on the timing, instructions and wording of some of the items. The item on parent highest education level was to be left out. The student age was to be categorised as14, 15, 16, 17 or >17 rather than an open number box for the student to fill his or her age. The subscales for SATMI were to be reduced to three: Mathematics Anxiety, Confidence to Learn Mathematics, and Motivation in Mathematics. Each scale was to have 12 items, six positively worded and six negatively worded. The items from each subscale were to be mixed throughout the questionnaire cyclically, but alternately between positive and negative items. The CLES, QTI and CEI sections of the instrument were all to be dropped in the final version of SATMI because the instrument was too long and some of the questions were not focusing on student attitudes. The analysis of the quantitative data was to be done using two-tailed t-tests, ANOVA and Pearson analysis in the main study. The use of Pearson coefficients was recommended for the analysis of quantitative data.

2. Problems one and two on MPST were to be re-written to reduce word density and provide shorter sentences. One problem on geometry (Problem 4) in the

MPST instrument was to be replaced because it proved too difficult for the students. Students performed poorly in this problem with more than half of them scoring zero. The duration of the MPST test was to be reduced to one hour from time unlimited. The maximum marks for each problem on MPST were to be distributed to 5 from the original 10 marks. The marking was to be based on the criteria looked for in each problem as: no attempt, inadequate, satisfactory or outstanding solution as in Appendix B2.

3. The structure of the LOP was retained for the main study. The sections were found appropriate to capture what the teachers were doing in their classrooms. The analysis of the LOP data was to be done using thematic analysis and quasi grounded theory. The transcriptions of the tapes proved a lengthy tedious process but were recommended to be conducted soon after the recording was completed. The qualitative data were to be analysed using a quasi-grounded theory approach from a predefined categories used during the pilot study to the establishment of categories emerging from the data.

4. The questions on the TIG were reduced to 17 semi-structured questions that covered general and classroom aspects including general information; the mathematics students; the lesson that was taught; the general teaching of mathematics; and the teacher's self-evaluation of the lesson taught. The analysis of the interview data was to be approached through an interpretive grounded theory approach. The language used was appropriately adjusted and effort was made to develop a conversational approach and to critically listen to what the interviewees were saying. That means asking good questions and

convincing people to answer them. More sensitivity was to be paid to non-verbal reactions and expressions.

5. The teacher practices categories of expository and constructivist teaching in the Teacher Practices Inventory that had been suggested proved difficult to analyse. The section on the categorisation was therefore to be withdrawn from the main study. The teachers only completed the open question on description of the flow of classroom events in a typical lesson in their teaching.

3.6 INSTRUMENTS FOR THE MAIN STUDY

3.6.1 Students attitudes toward mathematics inventory

The final SATMI instrument contained two sections A and B. Section A was on background information. The items in section B were modified from the Fennema-Sherman Attitudinal Scales only. Table 3.1 gives a sample of a brief description of the scales and two typical items for each scale, one positively and the other negatively worded from the questionnaire.

The SATMI inventory had a total of 36 items on student attitudes towards mathematics. It was intended to obtain measures of perceived student attitude toward mathematics. The scoring direction for the negatively worded items was reversed. The items were coded so that higher scores were related to less anxiety, higher confidence and higher motivation. The minimum and maximum possible scores on the instrument were 60 and 180 respectively.

Table 3.1: Description of Scales and Sample Items for the Student Attitude toward Mathematics Inventory (SATMI)

Scale name	Description	Sample items
Anxiety	Feelings of anxiety	Mathematics doesn't scare me at all (+) A mathematics test would scare me (-)
Confidence	Confidence in one's ability	I am sure that I can learn mathematics (+) I am not good at mathematics (-)
Motivation	Feeling competent	I like mathematics puzzles (+) Mathematics puzzles are boring (-)

Legend: (+) Positively worded items, these items are scored 1, 2, 3, 4, and 5 for the responses Strongly Disagree, Disagree, Undecided, Agree, and Strongly Agree.

(-) Negatively worded items, these items are scored 5, 4, 3, 2, and 1 for the responses Strongly Disagree, Disagree, Undecided, Agree, and Strongly Agree.

3.6.2 Mathematics problem solving test

The questions 1, 2 and 3 were retained but were simplified in language density. For example, the MPST problem illustrated in section 3.5 originally read:

> Paulo a senior three student is the School Sports Prefect and he has to plan a football tournament involving ten schoolhouse teams. He is not quite sure of how to find the total number of games to be played, if each house-team plays each other house-team once. The top eight teams enter the quarter finals to progress on a knockout basis, to determine the winning team. Please find for him the total number of games to be played and how you worked it out".

Two of the problems in the MPST were modified as will be described in the subsection on the content validity in section 3.7. In the final form, to be more gender sensitive, the name was changed to Anthony, a name both males and females can have in Uganda and a netball tournament was included with the football tournament. Question 4 on Geometry was:

A rectangular picture 1.2 m wide is centred on a wall that is 5m wide. What is the distance, in metres, from an edge of the wall to the nearer edge of the picture?

As mentioned earlier, this problem was poorly done by all students and was thought either too hard for the level of students or students had poor knowledge of geometrical concepts. This problem was replaced by the problem:

There are fewer than six-dozen eggs in a basket. If they are counted two by two there will be one left over. If they are counted three at a time there will be none left over. And if they are counted four, five, or six at a time, there will always be three left over. How many eggs are in the basket?"

3.6.3 Lesson Observation Protocol

The LOP instrument was retained in its original form. It was found suitable to capture the events in the classroom. The full text of the LOP is given in Appendix C.

The lessons observed were also audio taped, transcribed and summarised into Flanders' Interaction Analysis Categories (FIAC). The FIAC method had a number of weaknesses though because people who are being observed could change their behaviour. They could become uneasy or stop some activities altogether. In such cases observation could introduce biases as people became aware of being observed

(Bless & Higson-Smith, 2000). However, the Flanders interaction analysis was adapted.

Flanders interaction analysis system

In the Flanders (1970) interaction analysis system, the analysis categories are outlined in Figure 3.1. The classroom interaction activities were divided into three major components: (1) The teacher-talk; (2) the pupil-talk; and (3) the silence or confusion. The teacher-talk and the pupil talk were further divided into response and initiation categories. The teacher-talk included categories one to seven which entailed accepting feeling, praising or encouraging, accepting or using pupils' ideas, asking questions, lecturing, giving directions and criticising or justifying authority. These categories were further subdivided into teacher-response categories one to three: that captured: accepts feeling, praises or encourages, and accepts or uses ideas of pupils. The teacher-initiation categories five to seven, which involved lecturing, giving directions and criticising or justifying authority.

Category four (asking questions) was not allocated to any of those categories. The student-talk included categories eight and nine: pupil-talk response and pupil-talk initiation. These categories were further separated to into student-response category eight and student-initiation category nine. Category 10 stood alone as silence or confusion.

FLANDERS' INTERACTION ANALYSIS CATEGORIES* (FIAC)		
Teacher Talk	Response	1 *Accepts feeling.* Accepts and clarifies an attitude or the feeling tone of a pupil in a non-threatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included.
		2 *Praises or encourages.* Praises or encourages pupil action or behaviour. Jokes that release tension, but not at the expense of another individual; nodding head or saying 'Um hm?' or 'go on' are included.
		3 *Accepts or uses ideas of pupils.* Clarifying, building, or developing ideas suggested by a pupil. Teacher extensions of pupil ideas are included but as the teacher brings more of his own ideas into play, shift to category five.
		4 *Asks questions.* Asking a question about content or procedure, based on teacher ideas, with the intent that a pupil will answer.
	Initiation	5 *Lecturing.* Giving facts or opinions about content or procedures; expressing *his own* ideas, giving *his own* explanation, or citing an authority other than a pupil.
		6 *Giving directions.* Directions, commands, or orders to which a pupil is expected to comply.
		7 *Criticizing or justifying authority.* Statements intended to change pupil behaviour from non-acceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing; extreme self-reference.
Pupil Talk	Response	8 *Pupil-talk — response.* Talk by pupils in response to teacher. Teacher initiates the contact or solicits pupil statement or structures the situation. Freedom to express own ideas is limited.
	Initiation	9 *Pupil-talk — initiation.* Talk by pupils, which they initiate. Expressing own ideas; initiating a new topic; freedom to develop opinions and a line of thought, like asking thoughtful questions; going beyond the existing structure.
Silence		10 *Silence or confusion.* Pauses, short periods of silence and periods of confusion in which communication cannot be understood by the observer.

Figure 3.1: Flanders' Interaction Analysis Categories* (FIAC).

* There is no scale implied by these numbers. Each number is classificatory; it designates a particular kind of communication event. To write these numbers down during observation is to enumerate, not to judge a position on a scale. *(Source: Flanders, 1970:34)*

3.6.4 Teacher Interview Guide

The Teacher Interview Guide (TIG) was a semi-structured guide. It contained 17 key questions, which were explored with each teacher interviewee. There were also supplementary sub-questions within each question, which were used as prompts. Some of the questions were more open-ended than others. The TIG was divided into five sections on: general information; the nature of the mathematics students; the discussion of the lesson taught; mathematics teaching in general; and personal information. Within each section the issues discussed or focussed on the views on the school setup, the views of students, the views of lesson teaching and the views on the lesson taught as summarised in Figure 3.2.

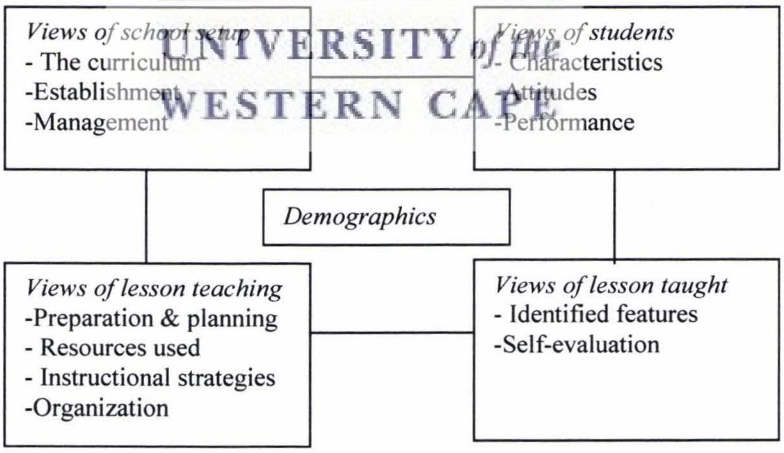

Figure 3.2: Themes Covered in the Teacher Interview Guide.

The detailed semi-structured TIG guide is given in Appendix D. This kind of interview guide was preferred to ensure fair uniformity of information generated with the exception of the issues on the "lesson taught" which varied from teacher to teacher.

Since the interview information gathering exercise followed after the observations, interviews were deemed most appropriate to obtain data to be treated as experiences or "actively constructed 'narratives'-involving activities" (Silverman, 2001:113). The choice of the interview approach for this study was guided by considerations that "interviews as a principal method of gathering information can be used to suggest hypotheses and as a means of following-up some interesting and unexpected behaviour from observations" (Silverman, 2001:113).

The TIG was designed to allow the teacher to explain some of the actions observed during the lesson and to clarify what was envisaged as an inconsistency or striking/unusual action. It has also provided answers on some of the issues raised during the lesson.

3.7 RELIABILITY AND VALIDITY IN QUANTITATIVE RESEARCH

This section briefly considers reliability and validity as it relates to quantitative research. It covers issues of reliability, validity: content validity, statistical validity and external validity.

3.7.1 Reliability

According to Carmines and Zeller (1979:11) reliability refers to the "extent to which any measuring procedure yields the same results on repeated trials." Reliability is a measure of how consistent the same method of data generation produces the same results. In this study, the item reliability estimate for SATMI were established using

Cronbach alpha coefficient (α) as a measure of internal consistency, because the items were scored on a Likert scale format.

3.7.2 Validity

Several authors have defined the concept of validity (Carmines & Zeller, 1979; Mason, 1996). Carmines and Zeller (1979:17) defined validity as the "extent to which any measuring instrument measures what it is supposed to measure, while Mason (1996) referred to it as "judgements about whether you are 'measuring', or explaining what you claim to be measuring or explaining…[that requires the researcher's] conceptual and ontological clarity" (Mason, 1996:146). Even though the definition of validity given by Carmen and Zeller (1979) and Mason (1996) differ semantically, they are similar in meaning. Both have the intent of fulfilling the researcher's goal. The Carmen and Zeller (1979) definition will be applied when considering the quantitative instruments. Meanwhile, the Mason (1996) definition will be useful for the interpretation of the qualitative data of this study.

Content validity or face validity

Meanwhile, content validity is based on the adequacy with which the items in an instrument measure the attributes of the study (Nunnally, 1978). The content validity of the MPST instrument was ensured through constructive criticism from graduate student colleagues in the Graduate Studies in Science, Mathematics and Technology Education (GRASSMATE) programme. The items were revised and improved upon according to advice and suggestions colleagues made. Further, the set of items were given to three experienced mathematics and science educators, with expertise in questionnaire construction and test development to check on the suitability of the questions and the language used. The recommendations made by supervisors and colleagues were incorporated during the modification of SATMI. The SATMI questionnaire content validity was taken a priori because it has been widely used in research on students attitudes towards mathematics.

Statistical validity

According to Neuman (2000:173) statistical validity requires that "the correct statistical procedure is chosen and its assumptions are fully met." Statistical validity refers to adhering to the major statistical assumptions about the mathematical properties of numbers used in the analysis. In this study, the statistical assumptions were met in choosing appropriate statistical tests and procedures for the various conditions of the method. This was guided by advice from qualified statisticians and statistics consultants.

External validity

Merriam (1998:207) refers to external validity as "the extent to which the findings of one study can be applied to other situations" (Merriam, 1998:207). This definition questions whether the conclusions of the study are transferable to other contexts and whether they are generalisable. For this study the reader draws external validity from the discussion in Chapter 6.

3.8 RELIABILITY AND VALIDITY IN QUALITATIVE RESEARCH

This section briefly considers reliability and validity as it relates to qualitative research. It covers issues of dependability, trustworthiness, credibility, transferability and confirmability.

3.8.1 Trustworthiness

Qualitative data should be evaluated in terms of its trustworthiness (Babbie & Mouton, 2001; Lincoln & Guba, 1985). Trustworthiness involves four alternative constructs: credibility, transferability, dependability and confirmability, which more accurately mirror the assumptions of the qualitative paradigm. The principles of reliability and validity though acceptable are seldom used in qualitative research. Instead equivalent terms: objectivity and validity that involve the concept of 'Munchhausen objectivity' (doing justice to the object of study) and 'trustworthiness' (the extent to which the qualitative research represents the truth or the neutrality of findings or decisions) are applied (Babbie & Mouton, 2001:274).

Denzin and Lincoln (1994:14) have suggested that in qualitative research the more positivist criteria like *internal* and *external validity, reliability,* and *objectivity* should be replaced by terms like *credibility, transferability, dependability* and *confirmability.* Though Silverman still described reliability in qualitative research as referring to "the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions" (Silverman, 2001:225). Babbie and Mouton (2001) expressed these comparisons in tabular form as illustrated in Table 3.2.

Table 3.2: Quantitative and Qualitative Notions of Objectivity.

Quantitative	Qualitative
Internal validity	Credibility
External validity	Transferability
Reliability	Dependability
Objectivity	Confirmability

(Source: E. Babbie & J. Mouton (2001).

3.8.2 Credibility

Talking about credibility prompts the question of how another researcher or participant could recognise that the findings of the study presented were true and believable. Mason has argued that to establish validity or credibility in qualitative research one could simultaneously show the validity of method and the validity of the analysis through two ways: (i) the validity of the data generation methods that could be achieved through explaining to other people or researchers how one arrived at the conclusion that the methods themselves were valid; and (ii) the validity of the interpretation raises the question of "how valid is your data analysis and the interpretation on which it is based" (Mason, 1996:149). Meanwhile, the validity of both method and analysis can best be shown "through a careful retracing and reconstruction of the route by which you think you reached them" (Mason, 1996:152). Credibility could be improved through peer debriefing and member checks (Babbie & Mouton, 2001). In the current study colleagues and supervisors were constantly interrogating both the methods and interpretations of the data generation and analysis and helped in improving the credibility of the findings.

3.8.3 Transferability or generalisability

Transferability connotes a view from a theoretical perspective by making theoretical assertions rather than empirical data from samples to populations. Transferability in this study was heightened through thick descriptions of the data and the careful explanation of the research setting and individuals.

3.8.4 Dependability

Dependability could be conceptualised as the mirror image fit between what the researcher recorded as data and what happened in the setting. For example, the question of whether the researcher reported accurately what a teacher was doing or saying at a particular site.

3.8.5 Confirmability

Confirmability entails providing clear observations in the final report and giving multiple explanations for the observations made. Confirmability is enhanced through respondent validation. The respondents were understood to have epistemological privilege imparted by social location and experiences were used to validate the data (Mason, 1996).

3.9 ETHICAL ISSUES

In every research process ethical issues and considerations must be made, addressed and adhered to. Strydom (2001a) defined ethics as:

> A set of widely accepted moral principles that offer rules for, and behavioural expectations of, the most correct conduct towards experimental subjects and respondents, employers, sponsors, other researchers, assistants and students. (Strydom, 2001a: 75).

Several authors have discussed ethical issues and considerations in the literature (Bless & Higson-Smith, 2000; Cohen, Manion, Morrison, 2000; Mason, 1996; Strydom, 2001a). Nearly all these authors raise the same issues. According to Mason (1996) the commonly discussed ethical issues and considerations include: the rights to privacy and voluntary participation; anonymity and confidentiality; high quality practice and the building of capacity of all sectors of the community or responsibility to produce good quality research. But, according to Strydom (2001a) while authors mostly discuss the same things on ethical issues, some authors discuss different classifications of ethical issues. Some authors broadly classify and discuss only few issues, while others do in-depth, detailed analysis about some issues.

Discussions of ethical issues semantically vary and depend on the degrees of emphasis that the different researchers adapt. For example, comparing issues that Bless and Higson-Smith (2000) raise and those raised by Strydom (2001a) the key issues discussed relate to paying due attention to care against harm to experimental subjects and/or respondents; obtaining informed consent; taking care against deception of subjects and/or respondents; avoiding the violation of privacy or anonymity or confidentiality (self-determination); taking care about actions and competence of researcher; cooperation with contributors; release or publication of the findings; and debriefing of the subjects or respondents, the claim of the predominance of semantics came afore. Thus, one could say ethical principles form the researcher's constitutional toolbox or working document containing internalised 'laws' to guide, protect and inform the researcher and others in implementing the research agenda.

In this study, ethical considerations of access, informed consent, guarding against participant deception, attention to anonymity and confidentiality were made as outlined below. The process also served to set standards to partially evaluate the research process:

1. Official clearance from the ethical committee to conduct the study in Uganda was received from the office of the President of Uganda through the Uganda National Council for Science and Technology (UNCST). The correspondence letters between the UNCST and the researcher are given in Appendix F for the researcher, Appendix G1 for RDC Kampala District, Appendix G4 for RDC Mpigi District, Appendix G7 for RDC Mukono District, and Appendix G10 for RDC Wakiso District. Further, access to study schools was obtained through the Resident District Commissioners, (RDCs) the District Education Officers (DEOs), and from the head-teachers of the school concerned. Clearance letters were also obtained form the RDCs to either the DEOs or to the head teachers as given in Appendix G2 for Kampala District, Appendix G5 for Mpigi District, and Appendix G8 for Mukono District. Clearance were also obtained from the DEOs to the head teachers given in Appendix G3 from DEO Kampala District, Appendix G6 from DEO Mpigi District, Appendix G9 from DEO Tororo District, and Appendix G11 from DEO Wakiso District.

2. The National examinations results were obtained from the Secretary UNEB by correspondence between the researcher and the Secretary as given in letters of communication given in Appendices E1, E2, E3 and E4 with a promise of confidentiality in handling the information.

3. Verbal informed consent for participation was obtained from teacher participants since there were no informed consent statements available for participants to read and sign. The students' consent was assumed a priori when the head teacher of a school allowed entrance to the school and gave the go-ahead to conduct the study.

4. Both the teacher and student participants were given an honest and fair explanation of the purpose and procedure of the study, which guarded against possible deception of participants.

5. Participating schools were first given code numbers. The participating teachers were given teacher code numbers and the participating students were also given identification case numbers. Next, in reporting the schools and the teachers were given pseudonyms to conceal their identity and to respect the right of participants' anonymity.

6. The participants were assured that the study data were only being used for research purposes. No unauthorised persons had access to the data and there was no intention to have the data known or revealed to conform to the confidentiality of the information. All the data obtained from UNEB, and the data and materials that were collected were kept confidential.

3.10 RESEARCH PROCEDURE

This section explains the research procedure that was adapted for this study. In particular it outlines: (1) the SATMI administration; (2) the MPST administration; (3) the lessons observations, using LOP; and (4) the teacher interviews, using TIG.

3.10.1 Administration of SATMI

The administration of SATMI proceeded as follows. The researcher delivered the SATMI questionnaires to the head of mathematics department in each school. The head of department administered the SATMI to the students in each school except in two schools where the instrument was administered by either the researcher or the research assistant in each of the two schools. Each school was also assigned an identification code number. Each student was given an identification number (ID) as is the practice of assigning candidates index numbers for the national examinations in the country. The participating students completed their ID numbers on the questionnaire. The invigilator checked against the master role that each student had correctly filled his or her ID. The questionnaire administrators were directed to only read and explain the questionnaire instructions to the students. The administration of the questionnaire lasted for about 45 minutes. The questionnaire administrator entered the school code number on each student's questionnaire after the student turned it in. The researcher personally collected the completed questionnaires from each school.

3.10.2 Administration of MPST

A fortnight after the administration of SATMI the MPST was delivered to each school. The writing of the MPST test was conducted under strict examination conditions in each school. Again the heads of department, the research assistant and the researcher invigilated the MPST at each school. The students were not allowed to bring in extra materials to the examination room except a mathematical set and writing implements. The students were provided with answer sheets. Most of the students completed the test within an hour. Some of the students who could not do some of the problems left the examination room earlier.

3.10.3 Lessons' Observation using LOP

The lessons observation followed the following procedure. Each teacher was contacted before being observed. A suitable time when the teacher was engaged teaching as per the school timetable was identified, agreed upon and arranged. The teachers taught the lessons as they had schemed and prepared them according to their school programme. The classroom environment was allowed to operate as it normally did. The lessons were of 40-minutes duration. The researcher and a trained research assistant (a graduate student) simultaneously observed lessons and made separate observation notes using the LOP. The trained research assistant was used to provide an alternative control check for the lessons that were systematically observed. After each lesson observation the research assistant and the researcher shared their comments and came up with an inter-observer agreed version of the teacher's record of the teacher's teaching.

The field notes and comments were made for each observation on the same day before the particular teacher was observed again. The audiotapes were transcribed within a day or two after recording. The field notes were used to construct 'thick descriptions' of what transpired in the classroom. The tape recorded data was transcribed and decoded using a Flanders coding sheet and later analysed.

3.10.4 Teacher interviews

The interviews with the teachers followed immediately after the lesson presentation. The interviews were conducted in a convenient place either in the head of department's office or in a quiet room. When a room was not available the interviews were conducted under a tree. Each interview lasted about 45 minutes. A sample of the interview data is presented in the following excerpt in Figure 3.3.

R:	There is discussion. I am the one also teaching the S.4 both paper1 and paper2 so I have attached them to S.4s for discussion at their free time. And you heard them say Saturday, because I normally meet them sometimes on Saturdays. I told them that I will be there from 10 a.m. up to mid-day. Please come with the problems and lead the discussion.
I:	So how do you ... the problems are theirs.
R:	Yes.
I:	And you will have given them to you in advance that these are the things we are going to discuss or how do you arrange this?
R:	O.k. what we do like now during the course of the week.
I:	Yes.

Figure 3.3 An Excerpt from the Interviews with One of the Teachers.

Legend: R for the Respondent, and I for the Interviewer

3.11 DATA ANALYSIS

3.11.1 Quantitative data analysis

Associations between attitudes toward mathematics and achievement in mathematics problem solving

The correlation between student attitudes toward mathematics and achievement in mathematics problem solving were investigated using Pearson correlation coefficients for the pooled data. Further, because of the differences by school-type and gender that were noted when the mean responses were examined. Correlation by groups that is school-type by gender combinations were investigated.

The Student Attitude toward Mathematics Inventory

Prior to the analysis of the SATMI and MPST data the reliabilities of the instruments were again computed. Using Cronbach alpha method internal consistency or reliability coefficient was established for each subscale and for the overall SATMI and MPST instruments.

The quantitative analysis addressed questions about differences in student attitudes toward mathematics. First, the scores on SATMI of negatively worded items were reversed so as to ensure that high scores meant agreement with the truth of the statements. Next, the responses were totalled on the individual items to obtain the scores for the sub-scales of Anxiety, Confidence and Motivation. Frequency counts for the outcomes of the variables of gender, school-code and school-type were calculated. Descriptive statistics (means and standard deviations) for Anxiety, Confidence, Motivation, and Achievement were computed for the composite scores on the sub-scales using SPSS Version 12 for Windows.

Differences in Student Attitudes toward Mathematics and Achievement by School-type and by Gender

Statistical analysis involved using student two-tailed t-tests for independent samples, using the class as unit of analysis; ANOVA; and Pearson correlation to investigate whether differences in student attitude toward mathematics and achievement in mathematics problem solving by school-type and gender using the SPSS Version 12 for Windows.

The mathematics problem solving test

A general scoring rubric for any open-ended problem was developed at the pilot phase of the project with a team of mathematics teachers. It was agreed that a score of one would be considered 'inadequate'; a score of two or three would be considered 'satisfactory'; and a score of four or five would be considered 'outstanding'. A score of zero was given to someone who turned in a blank answer sheet or no work done at all. The procedure used for the development of the generic scoring and particular problems rubric involved the following steps:

1. Students worked the problems.
2. Mathematics teachers did the same problems.

3. The researcher and the teachers discussed the students' solutions, for each problem together and rank ordered the student papers into five groups, with five being the highest rank and one the lowest.
4. The researcher and teachers discussed the characteristics of the solutions and devised a rubric for an outstanding rating five solution.
5. The rubric for the other categories were also agreed upon and expressed for each problem.
6. The exercise was repeated for clarification, and based on the rubric the student solutions are regrouped as necessary and generic rubric in Table 3.3 developed.

Table: 3.3 A generic rubric for scoring open-ended problems

CRITERIA	SCORE	SOLUTION
• Attempts to extend the problem; contains a full complete solution; correct interpretation of problem; correct strategy identified and followed.	5	As given
• Starts with a correct interpretation of the problem; identifies correct strategies; gives a complete solution with minor errors.	4	
• Interprets the problem correctly starts with a correct strategy; follows some wrong steps; part correct solution.	3	As given
• Gives incomplete solution; shows some errors; starts with an appropriate strategy.	2	
• Begins with an inappropriate strategy; misunderstands the question; shows major errors; incomplete solution.	1	As given
• No attempt or response	0	Nil

Descriptive statistics were then computed for the MPST scores as in Appendix A2. The differences in performance on the mathematics problem solving test between the students school-type and by gender were analysed using a t-test for independent samples, and one-way ANOVA.

3.11.2 Qualitative data analysis

The qualitative data analysis followed an interpretive approach. A practical guidance of grounded theory that sought to distinguish the processes that explain what was happening in a social setting (Strauss & Corbin, 1990, 1994) was followed. The data were analysed by the constant comparative method (Merriam, 1998; Miles & Huberman, 1994; Strauss & Corbin, 1990, 1994). In the constant comparative method:

> The researcher begins with a particular incident from an interview, field-notes, or document and compares it with another incident in the same data or in another set. These comparisons lead to tentative categories that are then compared to each other and to other instances (Merriam, 1998:159).

The concepts, events, phenomena, incidents and ideas were identified from the data through open coding first manually but later with the help of the Atlas/ti Hermeneutic Unit (HU) programme. Open coding involved naming the phenomena or concepts to give meaning to the data. Substantive codes were derived from words that were identified as giving meaning to the data. Such codes are often called 'in vivo' codes - derived from the words that the participants used. Continuously, questions were generated from the data and one concept was compared with another and each interview transcript was compared to another. As new ideas emerged further comparisons were made. Various formulations of categories were derived. For a detailed discussion of cross-sectional and categorical indexing; non-cross-sectional data organization; and the use of diagrams and charts as three non-mutually exclusive methods of sorting and organizing qualitative data see Mason (1996).

In other words, to consolidate, to reduce, and to interpret the qualitative data that were seen, read and heard from informants, "in some kind of integrated, complete, logical, succinct way" (Woods, 1986:125) and to avoid a possible pitfall that "if you don't know what matters more everything matters" (Miles & Huberman, 1994:55), the method of data handling suggested by Merriam (1998) was adapted. According to Merriam, the analysis of data process is a spiral process that involves five stages. First, the interview transcripts, field-notes or documents were taken and the data were read at three levels: literally, interpretively (reading through or beyond data) and reflexively (Creswell, 1998; Mason, 1996). Second, the comments, notes, observations and queries are jotted down the margin of the transcripts. Third, the comments on the margin are re-read to form groups. Fourth, groups of similar or like comments and notes are created. Finally, one returns to the first step to consider the next set of data. This process was repeated for other sets of data, while comparing notes and groups created. The groups formed were combined into categories.

The above descriptive procedure is mirrored in the spiral approach that Creswell (1998) describes. In the analysis conducted and to fasten the analysis process each transcript was read and re-read several times while listening to the corresponding section of the audiotapes in order to check the accuracy of the transcription and the understanding of each participant's experience. The transcripts were then converted to text files and entered into an Atlas/ti Hermeneutic Unit (HU) editor for coding and analysis. The transcripts were read and re-read and statements, phenomena and events that appeared related were similarly coded. Open coding was used to obtain initial categories of information about what the participants said, thus segmenting the information. The categories were construed as units of information made from events, occurrences, and instances (Strauss & Corbin, 1990). To get a feel of the coding process an excerpt from a transcript after coding as Atlas/ti output showing the initial codes is provided in Figure 3.4 that captures statements that were coded as students characteristics, teaching strategies, peer interaction and extra tutoring for teacher recorded here as P2 from a text file. Next, similarly coded events, statements that captured the meaning they conveyed as categories were grouped into themes. Each category's dimensions and subcategories and their associated properties were identified. The categories were discussed with graduate colleagues and refined. The categories in each interview transcript were compared and contrasted with the others.

Similarities and differences were identified and the overall phenomena that best described the experiences of the participants conceptualised. After identifying the categories their interrelationships were described.

P 2: interv2005.txt - 2:35 (224:227) (Super)
Media: ANSI
Codes: [Teaching strategies]

So I had to talk to them, give them the encouragement until now, whoever has a slight idea even if she is not sure of the rest of the working, will go to the blackboard. She wants to be corrected there.

P 2: interv2005.txt - 2:36 (233:234) (Super)
Media: ANSI
Codes: [Peer interaction]

There is discussion. I am the one also teaching the S.4 both paper1 and paper2 so I have attached them to S.4s for discussion at their free time.

P 2: interv2005.txt - 2:37 (235:237) (Super)
Media: ANSI
Codes: [Extra tutoring and/or periods]

And you heard them say Saturday, because I normally meet them sometimes on Saturdays. I told them that I will be there from 10 a.m. up to mid-day. Please come with the problems and lead the discussion.

Figure 3.4: An Excerpt of an Output from a Transcript after Coding Using Atlas/ti.

To explain the general spiral analysis process a bit further, it is illustrated in Figure 3.5 (Creswell, 1998). The analysis process started from the point of data collection (left hand side of the figure) and ended with a narrative account (on the right hand side of the figure). To analyse qualitative data, one moved through progressive circles of repeated actions that give the spiral. As the analysis proceeded the data were repeatedly organised, questions were asked, comparisons were made and new displays made of the emerging information. Each loop entailed five steps: The data management, where the data was organised forms the first loop that LeCompte (2000) called 'tidying up' the data.

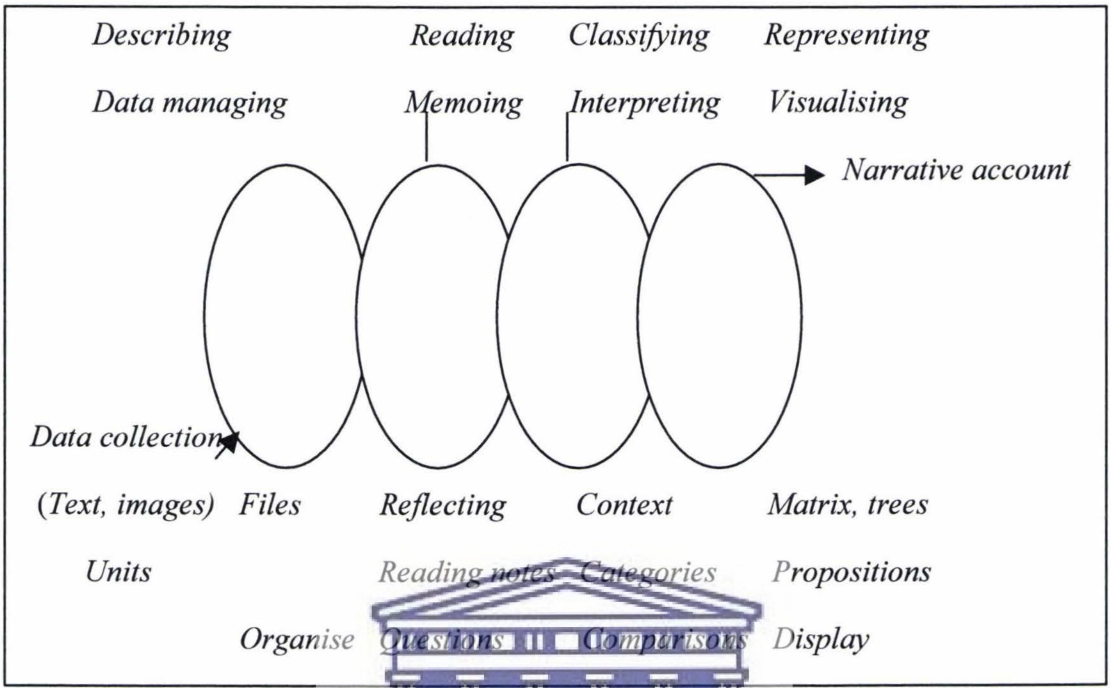

Figure 3.5: Spiral Process of Construction of Categories and Themes.

The reading and re-reading of transcripts, listening and re-listening to recorded audiotapes, making comparisons while reflecting and making notes and memos forms the second loop. The classifying and interpreting of the emerging phenomena into themes and categories occurred in the third loop. Representing and displaying (Miles & Hurberman, 1994) of the data formed the fourth loop. Finally, one emerged from the loops with the interpretations that gave a narrative account to the data.

3.12 SUMMARY

This chapter described the specific research questions for the study. Quantitative and qualitative research methods for the study were motivated by the need for rich data. Quantitative methods provided the numerical data while qualitative methods generated non-numerical data. The combined quantitative and qualitative approach produced both numerical and non-numerical data. The sampling procedure involved accessing the mathematics national examinations results for the year 1998 and 1999. After obtaining the results then followed the categorisation and identification of schools, the appropriate selection of teacher and student samples.

This chapter described the development, the administration of the instruments, the methodological issues of validity and reliability of quantitative research including credibility, transferability, dependability and confirmability in qualitative research. The chapter also highlighted the research ethics involving the protection of participants' rights. The evaluation of the pilot study suggested a number of modifications on the study instruments. In particular the SATMI instrument was reduced in size. The experience of the pilot study enlightened how the main study would be conducted.

CHAPTER 4

RESULTS: STUDENT ATTITUDES TOWARDS MATHEMATICS AND ACHIEVEMENT IN MATHEMATICS PROBLEM SOLVING

4.1 INTRODUCTION

This chapter presents the quantitative results of this study that investigated the relationship between student attitudes towards mathematics and achievement in mathematics problem solving in Ugandan secondary schools, while the next chapter presents the qualitative results of the study on the nature of teacher practices in HP- and LP-schools. The raw data for the quantitative analysis were obtained from the SATMI questionnaire, and the MPST test. Descriptive and inferential statistics were used to analyse, answer the research questions, and test hypotheses. In particular, the focus was on (a) the psychometric properties of the instruments; (b) the descriptive statistics of the sample; (c) the correlation between student attitudes toward mathematics and student achievement in mathematics problem solving; (d) the comparison of student attitudes towards mathematics by school-type; (e) the comparison of student attitudes towards mathematics by gender; (f) the comparison of student achievement in mathematics problem solving by school-type; (g) the comparison of student achievement in mathematics problem solving by gender; and (h) the comparison of student attitudes and achievement in mathematics problem solving by combined school-type and gender.

4.2 FINDINGS OF THE STUDY

4.2.1 Psychometric properties of the instrument

The psychometric properties of instruments include their reliability or internal consistency, the validity, the scale and composite means and standard deviations, the item-total correlations, the inter scale correlations and factor analysis of the instrument (Moely, et al., 2002; Streiner & Norman, 1995). In this study only the reliability, validity, scales means and standard deviations are reported. The internal consistencies of the subscales given by Cronbach-alpha reliability coefficients were computed using the Statistical Package for Social Sciences (SPSS) for Windows Version 12. The alpha coefficient values were .82 for AXTY, .85 for CONF, and .67 MOTV, which was a little low. These alpha-values are reasonably high, except for the Motivation scale. Cronbach alpha reliability values as low as .70 have been accepted to be useful for research purposes (Guildford & Fruchter, 1978).

4.2.2 Descriptive statistics of the sample

Table 4.1 shows the distribution of males and females in the two types of schools. The table shows the frequencies and percentages of student distribution by school-type and by gender. The school-type is taken to be either the high-performing or the low-performing schools. The gender is the sex of the student either male or females. There were a total of 254 students with complete results, which were used for the analysis in the study from an initial 279 students. Overall 151 (59.4%) students were from HP-schools (78 male and 73 female), and 103 (40.6%) were from the LP-schools (45 male and 58 female). The student ages ranged from 14 to 20 years with a mean age of 16.4. The students' Primary Leaving Examinations (PLE) grades on admission represented the entire 9-point national grading scale, from distinction pass to fail. The UNEB grading system uses grades 1 and 2 as distinctions, grades 3 through 6 as credits, grades 7 and 8 as passes and grade 9 as a fail. Twenty five students had incomplete results and were excluded from the analysis. There are numerically more participants from the HP-schools because one LP-school could not be located and was therefore not used for the study.

Table 4.1: Number and Percentages of Students by School-types and Gender

	GENDER	NUMBER	PERCENT
HP-SCHOOLS	Male	78	51.7
(5 Schools)	Female	73	48.3
	Total	151	100.0
LP-SCHOOLS	Male	45	43.7
(4 Schools)	Female	58	56.3
	Total	103	100.0

Table 4.2 shows the descriptive statistics for the entire sample by School-type and Gender. The table shows the sample size (N), the means (M) and standard deviations (SD) for the attitudinal variables Anxiety, Confidence and Motivation and the Achievement in Mathematics Problem Solving (ACHV) scores. The scoring was such that higher scores on Anxiety scale indicate lower anxiety. The frequency scores, percentages and cumulative frequencies for each SATMI scale and the ACHV are given in Appendix A2 by school-type (HP- and LP-schools).

Table 4.2: Means, Standard Deviations for Attitudinal Factors and Achievement in Mathematics Problem Solving by School-type and Gender.

			VARIABLES							
			AXTY		CONF		MOTV		ACHV	
School-type	Sex	N	M	SD	M	SD	M	SD	M	SD
HP-	M	78	46.8	7.9	48.6	8.2	45.4	6.3	40.1	27.4
	F	73	42.9	9.5	44.3	9.4	43.6	6.9	34.7	23.0
	Total	151	44.9	8.9	46.5	9.1	44.5	6.7	37.5	25.4
LP-	M	45	41.2	9.3	40.4	10.2	39.2	7.0	26.1	27.3
	F	58	38.8	8.5	39.9	8.9	39.0	5.9	27.1	27.3
	Total	103	39.8	8.9	40.2	9.5	39.1	6.4	26.7	27.2

Legend: AXTY = Anxiety; CONF = Confidence; MOTV = Motivation; ACHV = Achievement in Problem Solving

A comparison of mean scores within schools and between schools by school-type and gender were conducted using a two tailed t-test. An inspection of the means in Table 4.2 shows that overall the means of the students in the HP-schools are higher than those in the LP-schools on all the four variables.

In comparing the means by gender, the males in the HP-schools had higher means in all the variables than the females. Similarly, in the LP-schools the males had higher means than the females except in the ACHV where the females had higher means (M = 27.1) than the males (M = 26.1). Although the females had higher means than the males on ACHV the difference was not significant. The males in the HP-schools had higher means in all the attitudinal variables than the males in the LP-schools. Likewise, the females in the HP-schools had higher means than their counterparts in the LP-schools. The students' mean on the ACHV in the LP-schools (M = 26.7) was lower than that of the students in the HP-schools (M = 37.5). These differences were significant between the two types of schools.

To give a visual picture of the results Box and Whisker plots were drawn. The Box and Whisker plots for the data are presented in Figure 4.1, a-d. The plots for the attitude scales and achievement in mathematics problem solving are given. A critical look at the box plots reflects a similar pattern to that in Table 4.2. Figure 4.1 (a) shows higher means on the AXTY (Anxiety) scale of the males than those of the females both in HP- and LP-schools.

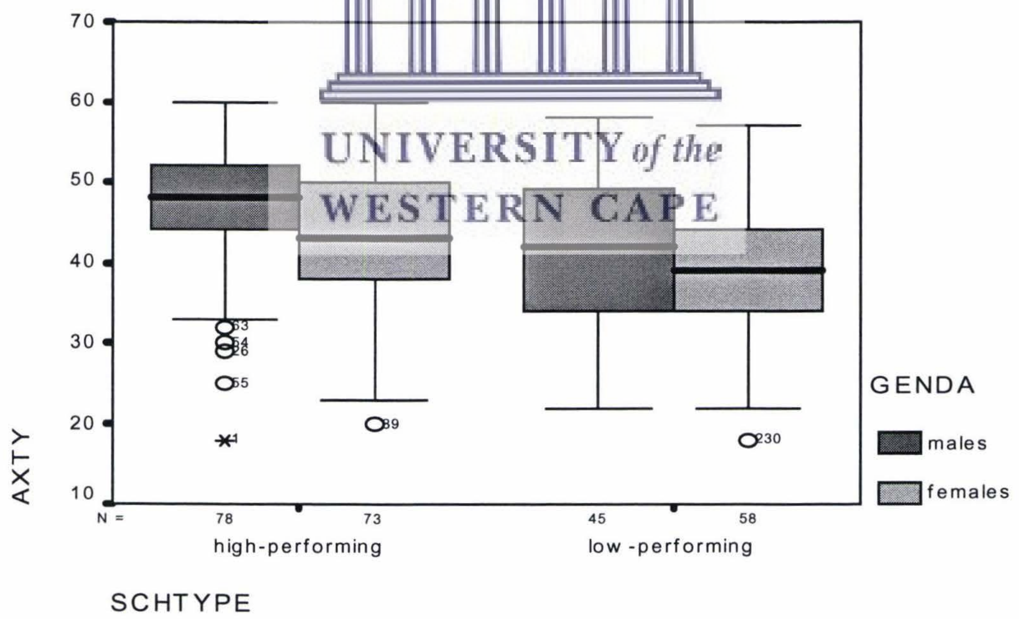

Figure 4.1 (a): Box Plot for Mathematics Anxiety by School-type and Gender.

There is a higher variation in the levels of anxiety among the males in the LP-schools than any other group. The smallest level of within school-type variation in anxiety is among the males is again in the HP-schools. Anxiety levels of the females in the HP-schools are nearly identical to the anxiety level of the male students in the LP-schools.

In Figure 4.1 (b) the scores for the CONF (Confidence) scale show that the means of the males are higher than those of the females in both the HP- and LP-schools. The largest level of within school-type variation on the Confidence scale is among the males in the LP-schools. The students in the LP-schools also have a larger range of scores. The males in the HP-schools have the smallest range of scores on the Confidence scale.

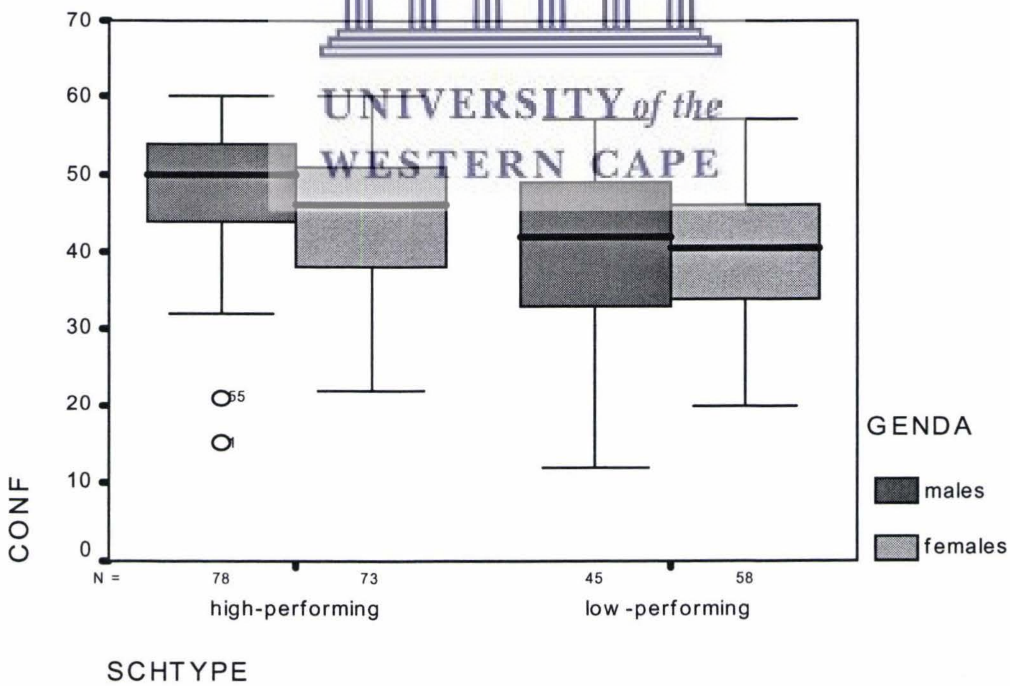

Figure 4.1 (b): Box Plot for Confidence in Learning Mathematics by School-type and Gender

In Figure 4.1 (c) the scores on the MOTV (Motivation) scale show that the means of the males are higher than those of the females in both the HP- and LP-schools. The means of the students in the HP-schools are higher than those in the LP-schools. The scores of the males and the females in the HP- and LP-schools are nearly identical, but there is a small variation among the females. The male students in the LP-schools have a large range of scores. The males in the HP-schools have the smallest range of scores on the Motivation scale.

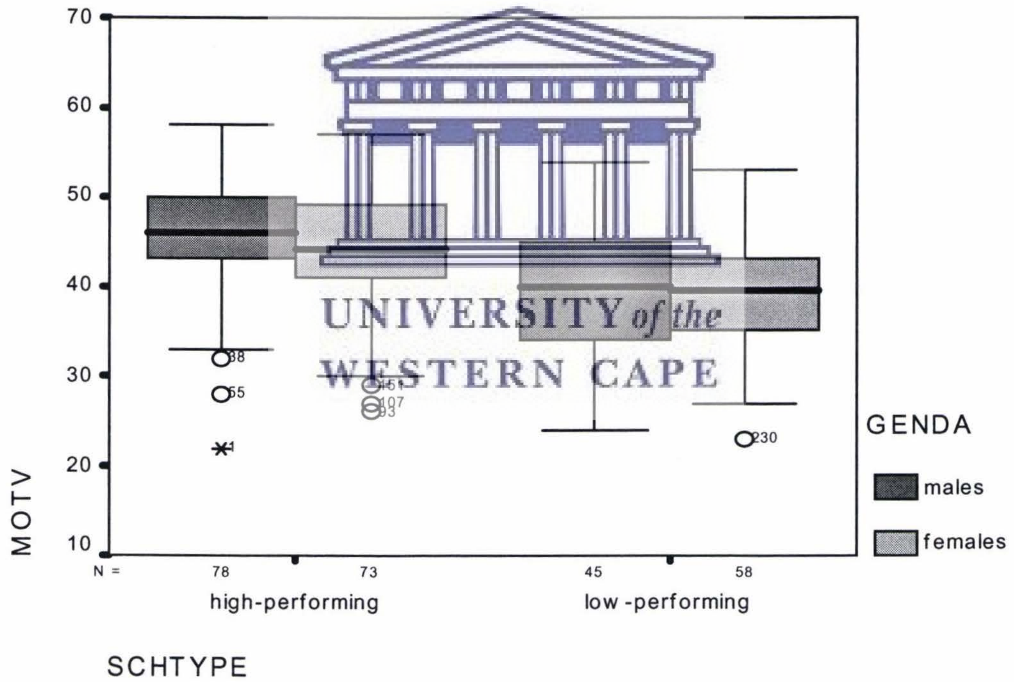

Figure 4.1 (c): Box plot for Motivation in Mathematics by School-type and Gender

Figure 4.1 (d) shows that the means on the ACHV are all below 50%. The highest variation in achievement is in the scores on the ACHV ranging from zero to 100%. The means of the males and females on ACHV are nearly identical in the two types of schools. The largest within school-type variation in scores occurred among the males in the LP-schools. The females in both the HP- and LP-schools had smaller means variation (7.6 units) than the males with a means range of 14.0 units. The ACHV frequency scores, percentages and cumulative frequencies for the HP- and LP-schools are given in Appendix A2 for ease of reference.

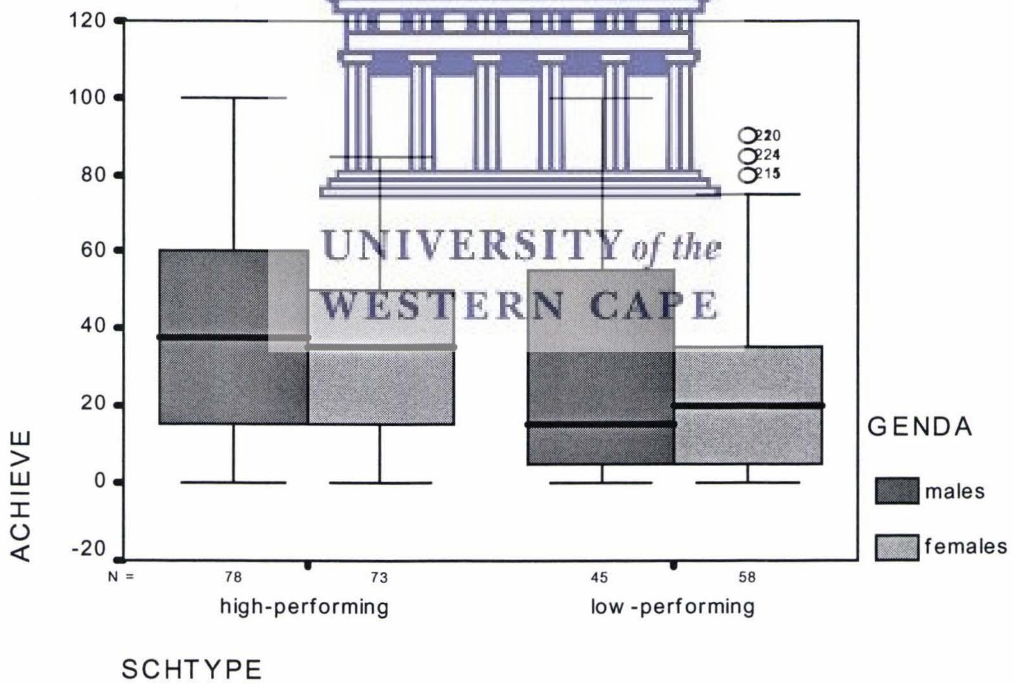

Figure 4.1 (d): Box Plot for Achievement in Mathematics Problem Solving by School-type and Gender

Table 4.3 shows the descriptive statistics for the attitudinal variables and achievement in mathematics problem solving by gender. Inspections of Table 4.3 shows that overall the male students have higher means for all four variables. The difference in means are however not statistically significant.

A scrutiny of the standard deviations in attitudes towards mathematics and achievement in mathematics problem solving were similar among males and females except in ACHV.

Table 4.3: Means, Standard Deviations for Attitudinal Factors and Achievement by Gender.

		VARIABLES							
		AXTY		CONF		MOTV		ACHV	
GENDER	**N**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Male	123	44.7	8.8	45.6	9.8	43.2	7.2	35.0	28.0
Female	131	41.1	9.3	42.4	9.4	41.6	6.8	31.3	25.2
Overall	254	42.8	9.2	43.9	9.7	42.5	7.1	33.1	26.6

Legend: AXTY = Anxiety; CONF = Confidence; MOTV = Motivation; ACHV = Achievement in Mathematics Problem Solving

4.2.3 Correlation between student attitudes toward mathematics and student achievement in mathematics problem solving

Question 1: Are there relationships between student attitudes toward mathematics and achievement in mathematics problem solving?

The Pearson r correlation coefficients between Mathematics Anxiety, Confidence and Motivation measured by the SATMI, and ACHV measured by the

MPST were computed and given in Table 4.4. The table shows a correlation matrix of the three attitude scales and the MPST measures of mathematics achievement. The results indicate positive correlations of achievement in mathematics problem solving with anxiety (AXTY), confidence (CONF) and motivation (MOTV). These low correlations were significantly ($p < .05$ for all of them) different from zero. The findings revealed a low but significant ($p < .05$) positive correlation between attitudes towards mathematics and achievement. The null hypothesis that "there is no significant relationship between student attitudes towards mathematics and their achievement in mathematics problem solving" was rejected. Based on this result, it was concluded that attitudes towards mathematics and ACHV are related.

Table 4.4: Pearson Correlation Coefficients Matrix between Attitudes Variables and Achievement in Mathematics Problem Solving and Significance Levels

Variable (N= 254)	AXTY	CONF	MOTV	ACHV
AXTY	1.0	.782* (.000)	.664* (.000)	.148* (.018)
CONF		1.0	.766* (.000)	.182* (.004)
MOTV			1.0	.185* (.003)
ACHV				1.0

* $p < .05$

4.2.4 Comparison of student attitudes towards mathematics by school-type

Question 2a: Are there differences in student attitudes toward mathematics (Anxiety, Confidence and Motivation) by school-type?

To answer the question posed above the mean scores on each attitudinal variable for students in the HP-schools were compared to the mean scores of the students in the LP-schools. To do this comparison, an independent two-tailed t-test of equality of means was done for each variable separately. Table 4.5 shows the Anxiety scale result is $t(252) = 4.44$, $p < .05$. Therefore, there is a statistically significant difference between student scores on Anxiety between students in HP- and LP-schools. The mean difference in anxiety scores was 5.1 units, with students in HP-schools showing higher anxiety scores and therefore less anxiety. The Confidence scale result is $t(252) = 5.39$, $p < .05$ indicates significant difference in Confidence between students in HP- and LP-schools. Therefore, there is a statistically significant difference between student scores in Confidence between students in HP- and LP-schools, with a mean difference in scores of 6.3, with the students in the HP-schools showing more confidence than the students in the LP-schools. The Motivation result is $t(252) = 6.47$, $p < .05$ indicates that there is statistically significant difference in Motivation between students in HP- and LP-schools. The mean difference in motivation scores was 5.4 units, with students in the HP-schools being more motivated than the students in the LP-schools. Thus, for all the attitudinal variables the null hypothesis that "there is no significant difference in attitudes toward mathematics between students from HP-schools and students from LP-schools" was rejected. This demonstrates that students from the HP-schools were different from the students in the LP-schools in the levels of their attitudes towards mathematics.

Table 4.5: t-Test Comparison of Student Attitudes towards Mathematics by School-type

Variable	t	df	*p*
Anxiety	4.44	252	.000*
Confidence	5.39	252	.000*
Motivation	6.47	252	.000*

*p< .05

4.2.5 Comparisons of student attitudes towards mathematics by gender

Question 2b: Are there differences in student attitudes towards mathematics by gender?

The mean scores of the male students on the attitudinal scales were compared to the mean scores of the female students. In order to accomplish this comparison, an independent two-tailed t-test of equality of means was done for each attitudinal variable with a type I error rate of .05 for each variable. Table 4.6 shows the computed values for each attitudinal variable. The result for the Anxiety scale is $t(252) = 3.21$, $p < .05$. There is a statistically significant difference in Anxiety between male and female students. The mean difference in Anxiety scores was 3.6 units, with the males showing more anxiety than the females. The results for the Confidence scale is $t(252) = 2.69$, $p < .05$, which indicates a statistically significant difference in confidence to learn mathematics between male and female students, with a mean difference in Confidence scores of the males being 3.2 units above that of the females. The result for the Motivation scale is t(252) = 1.79, p > .05. There is no evidence to suggest that difference in motivation exist by gender. Thus, for Anxiety and Confidence variables the null hypothesis that "there is no significant difference in attitudes toward mathematics between male and female students" was rejected. This shows that male students were different from the female students in the levels of those attitudes. But, for the motivation variable the null hypothesis was accepted. This indicated that there was no difference in motivation between the male and female students studied.

Table 4.6: Comparing Student Attitudes towards Mathematics by Gender.

Variable	t	df	*p*
Anxiety	3.21	252	.001*
Confidence	2.69	252	.008*
Motivation	1.79	252	.075

*p< .05

4.2.6 Comparisons of student achievements in mathematics problem solving by school-type and by gender

Question 3a: Are there differences in student achievement in mathematics problem solving by school-type?

The mean scores on achievement in mathematics problem solving of the students in the HP-schools were compared to the mean scores of the students in the

LP-schools. Table 4.7 shows that t(252) = 3.24, p<.05. The mean scores on achievement in problem solving for students in HP-schools were compared to the mean scores of the students from LP-schools. The results of the problem solving assessment show that students in the HP-schools performed better in problem solving than their counterparts in the LP-schools.

Table 4.7: Comparing Achievement in Mathematics Problem Solving by School-Type

Variable	t	df	*p*
Achievement	3.24	252	.001*

*p< .05

Question 3b: Are there differences in student achievement in mathematics problem solving by gender?

The mean scores on achievement in problem solving of male students were compared to the mean scores of the female students. Table 4.8 shows the comparison on student ACHV to be t(252) = 1.08, p > .05. Therefore, there is no evidence to suggest that there is a difference in ACHV between male and female students. Thus, for the MPST the null hypothesis that "there is no significant difference in achievement in mathematics problem solving between male and female students" was accepted. This result indicated that there was no evidence to show difference between male and female students in their achievement. This results leads to the conclusion that there is no difference in achievement in mathematics problem solving by gender.

Table 4.8: Comparing Achievement in Mathematics Problem Solving by Gender

Variable	t	df	*p*
Achievement	1.08	252	.279

*p< .05

4.2.7 Simultaneous comparisons of student attitudes and achievement in mathematics problem solving by school-type and gender

Question 4: Are there interaction effects between school-type and gender on student attitudes towards mathematics and achievement in problem solving?

A univariate ANOVA was used to compare student attitudinal variables and ACHV by school-type and gender. The variables were compared for students from HP- and LP-schools and the males and females were compared within and across each type of school using a 2 by 2 contingency table. Table 4.9 shows results for the analysis of the Anxiety scores. The ANOVA revealed significant main effects for gender, $F(1, 250) = 7.72$, $p < .05$ and school-type, $F(1, 250) = 18.43$, $p < .05$. The male students obtained a mean of 43.98 on anxiety which showed they had slightly lower anxiety than the females who obtained a mean of 40.85 by about four points. At the same time students in HP-schools scored (M = 44.89) which expressed overall lower anxiety than their counterparts in the LP-schools (M = 39.84).

Table 4.9: ANOVA Summary Table for the Anxiety Score by Gender and School-type

Source of Variation	SS	df	MS	F	*p*
Gender	593.87	1	593.87	7.72	.006*
School-type	1418.56	1	1418.56	18.43	.000*
Gender x School-type	38.99	1	38.99	.51	.477
Error	19243.54	250	76.97		

*p < .05

ANOVA was performed on the Confidence scores as Table 4.10 shows. The ANOVA revealed a significant main effect for gender, $F(1, 250) = 4.21$, $p < .05$, and School-type, $F(1, 250) = 28.55$, $p < .05$. The male students expressed slightly higher confidence (M = 44.51) than the females (M = 42.11) by about four points; and students in HP-schools (M = 46.51) obtained overall higher scores on Confidence scale than their counterparts in the LP-schools (M = 40.15) which indicated less confidence.

Table 4.10: ANOVA Summary Table for the Confidence Score by Gender and School-type

Source of Variation	SS	df	MS	F	*p*
Gender	350.09	1	350.09	4.21	.041*
School-type	2375.65	1	2375.65	28.55	.000*
Gender x School-type	212.55	1	212.55	2.55	.111
Error	20806.09	250	83.22		

*p < .05

For the Motivation scores, results in Table 4.11 shows that ANOVA revealed a significant main effect for school-type, $F(1, 250) = 40.93$, $p < .05$ only. Students in HP-schools (M = 44.54) expressed overall higher motivation than the students in the LP-schools (M = 39.13).

Table 4.11: ANOVA Summary Table for the Motivation Score by Gender and School-type

Source of Variation	SS	df	MS	F	*p*
Gender	61.69	1	61.69	1.45	.230
School-type	1746.22	1	1746.22	40,93	.000*
Gender x School-type	38.68	1	38.68	.91	.342
Error	10666.59	250	42.66		

*p < .05

For the ACHV scores results are presented in Table 4.12. The ANOVA shows a significant main effect for school-type, $F(1, 250) = 10.34$, $p < .05$. Students in HP-schools (M = 37.40) had higher ACHV than their counterparts in the LP-schools (M = 26.59). There was no significant gender effect $F(1, 250) = .43$. Females' ACHV was similar to that of the males. Thus, for all the attitudinal variables the null hypothesis that "there are no significant interactions between school-type, gender and achievement in mathematics problem solving" was rejected for school-type and gender. But, the hypothesis was accepted for gender in mathematics problem solving. There were no interaction effects were detected between school-type and gender.

Table 4.12: ANOVA Summary Table for the Achievement Scores by Gender and School-type

Source of Variation	SS	df	MS	F	P
Gender	290.78	1	290.78	.43	.515
School-type	7077.52	1	7011.52	10.34	.001*
Gender x School-type	600.74	1	600.74	.88	.350
Error	171115.37	250	684.46		

*p < .05

4.3 SUMMARY

This chapter presented the quantitative findings of this study for each attitudinal variable and ACHV by school-type and by gender. There were low positive correlations between mathematics anxiety, confidence to learn mathematics and motivation in mathematics and ACHV. There were statistically significant differences in all the four variables (Anxiety, Confidence, Motivation and ACHV) by school-type. But, whereas there is a statistically significant difference in mathematics anxiety and confidence to learn mathematics between males and females, there was no evidence to suggest a significant difference in motivation to learn mathematics and achievement in mathematics problem solving by gender.

ANOVA revealed significant main effects for mathematics anxiety and confidence to learn mathematics by gender and school-type. However, there was a significant main effect for motivation and achievement in mathematics problem solving by school-type only.

CHAPTER 5

RESULTS: TEACHERS' INSTRUCTIONAL PRACTICES

5.1 INTRODUCTION

This chapter presents the qualitative results on the nature of teacher practices in HP- and LP-schools in sampled Ugandan secondary schools. The chapter covers data related (1) to pursuing excellence: (a) classroom learning environment structures; (b) management of teaching; (c) planning and preparation; (d) diagnosis of student difficulties; (e) instructional approaches; and (f) additional teaching sessions. And (2) to enhancing participation: (g) the teacher engagement and behaviour; (h) teacher-student interaction; (i) student engagement during lessons (j) the teacher conceptions and attitudes about students; (k) student grouping strategies; (l) assessment and evaluation; and (m) presentations of lessons.

The analysis of the qualitative data followed a quasi-grounded theory approach. Codes were assigned to the pieces of data and then categories developed from the codes. The data revealed two primary theoretical constructs: *pursuing excellence* and *enhancing participation* emerged drove the analysis. The results presented here were from the four teachers who were purposively selected to participate in qualitative part of the study. The transcripts data were reported as (N-X) where N is the teacher and X was the mode of data capture: INT for interviews.

5.2 PURSUING EXCELLENCE

Pursuing excellence deals with what teachers do in order to improve student achievement. It thus deals with the question: What do mathematics teachers do in their mathematics classrooms in the HP- and LP-schools?

The findings of this study indicate that the teachers tried to improve student achievement through paying attention to: (1) the classroom-learning environment structure; (2) the management of teaching; (3) planning and preparation; (4) the diagnosis of student difficulties (5) the instructional approaches; and (6) additional teaching sessions. These findings are discussed below and are summarised in Table 5.1 by components and school-type.

5.2.1 Classroom-learning environment structure

The classroom-learning environment structure refers to the material resources that teachers use in the classroom and how they were used. The classroom learning environment was determined by three issues coded as (1) instructional resources and materials, (2) the use of technology, and (3) classroom organisation.

Instructional resources and materials

The instructional resources included textbooks, supplementary materials and equipment that were used for teaching mathematics. In the analysis of the use of instructional materials and resources five ways of working were identified. First, the teachers in the HP-schools used a wider variety of textbooks, which included personal- and Ministry of Education and Sports (MoES)-prescribed textbooks, than the teachers at the LP-schools. At HP2, for example, several textbooks were used for the different courses offered. For the general 456-Mathematics course T2 stated that for "the 456-Mathematics we have like four textbooks we use..." Four-five-six-Mathematics is the national syllabus that all secondary schools in the country follow. As pointed out earlier mathematics is compulsory and so the 456-Mathematics course is compulsory. Furthermore, according to T2, they also used other two textbooks: "there is one we call Clarke, and then there is another one...in fact it is Parr." (Clarke and Parr are the names of the author of each of the textbook referred to). In contrast, teachers in the LP-schools complained of shortage of resources. There were relatively fewer resources and materials at the teachers' disposal. During mathematics lessons students hardly used any textbooks. Usually the only available textbook was the one for the teacher.

Although there was a shortage of textbooks at the LP-schools it was evident that the teachers carried, consulted and read different books to prepare teaching notes. This was at least the case in LP1 as T3 testified:

> I normally carry my own books, for instance, and I use various textbooks. I use School Mathematics by Parr, I use Essential Mathematics for those in senior three, then I have other textbooks, which I normally consult. So what I normally do is, I go home and read a chapter, I consult those books, prepare my lesson, then I use that as basis for teaching my lesson (T3-INT).

Second, the teachers in the HP-schools reported using several instructional materials. Apparently all the schools in the study used School Mathematics for East Africa (SMEA), which is one of the textbooks prescribed by the MoES for this level. In addition, the HP-schools recommended other textbooks for their students. For instance, when teacher T1 was asked what mathematics textbooks they used at their school he explained that they also used the Secondary Mathematics for Uganda (SMU) textbook among others:

> We use the common ones for the students like School Mathematics for East Africa…then we add others like Secondary Mathematics for Uganda, like Fountain Books Series. Like this one here, this is Secondary School Mathematics. So these are the textbooks we use… (T1-INT).

Third, teachers in the HP-schools also used physical models such as teaching aids and local material from the environment to try to relate mathematics to some context. The local materials were particularly used for specific topics. For example, at HP1 when T1 taught a topic on Statistics he had brought in tape measures to measure student heights. He argued that that was what he usually does when he comes to teach. "I come when I am prepared and I use local or common information and everyday things which happen that are related to mathematics" (T1-INT). T1 defended his action of using models to teach three dimensional geometry saying:

> Like…some topics, like 'three dimensions' I had to make an open model, a skeleton of the pyramid, a skeleton of the cuboids and then a plane and a line. I show them and they were getting it well. At the beginning they were seeing it tough but at the end they got the things well... (T1-INT).

The practice of using models and teaching aids contrasted with what the teachers in the LP-schools did. The teachers in the LP-schools hardly used models and teaching aids for their teaching. The use of models was a strong case of trying to connect mathematics to everyday life. Such a practice is in line with what the standards documents NCTM (2000) proposed, advocated for, and suggested as practices that should be integrated in classroom activities in mathematics classrooms, especially in the United States. The use of models is also a possible avenue for creating a connection between in-school and out-of-school mathematics (Civil, 2002; Masingila, Davidsenko & Prus-Wisniowska, 1996) which seems an area of great need. Because the teachers in the LP-schools hardly used any teaching aids or models in their teaching they instead theoretically taught mathematical concepts.

Fourth, teachers in the HP-schools used textbooks, UNEB past-papers booklets and the school's past-papers as a source of their exercises and problems. UNEB past-papers booklets are a compiled set of past examination questions covering several years that are produced by UNEB and sold to schools and interested individuals. Meanwhile the teachers in the LP-schools did not seem to have UNEB past-papers available and heavily relied on the school's past-papers.

Fifth, at HP1 the school acquired textbooks for the students. T1 explained that because the parents previously had difficulties in finding the textbooks, "the school decided to buy the textbooks for the students." This arrangement means that students had their own copies of the school recommended textbooks. However, it was observed that at this school the students usually did not have textbooks with them during lessons, although they were always given exercises to do from the textbook. Presumably textbooks were available to them for after school use only. At HP2 the school supplied textbooks to the students to share.

Use of technology

The use or application of technology entails the use of calculators and computers for teaching mathematics. Calculators were the main technology used in teaching mathematics. Teachers in both HP- and LP-schools used calculators but there were no computers observed in the classrooms. However, there were more calculators in the HP-schools with each student having one than in the LP-schools where they were shared. Teachers in the HP-schools reported that students had personal calculators that were used in their classrooms. But, in the class at LP1 with 32 students it was observed that there were only ten calculators shared among the students. In the HP-schools teachers used calculators in every topic that involved calculations, but in the LP-schools the teachers encouraged students to solve problems using either a calculator or logarithmic tables whichever was available.

Furthermore, T3 reported that at LP1 there was enthusiasm among the students to use calculators in addition to using logarithmic tables. This student eagerness challenged the teacher to work problems using both logarithmic tables and the calculator. However, doing so further challenged the teacher to attend to different student needs. T3 explained that:

> When I am doing a number, which involves calculations, I carry mathematical tables…then other people [students] use calculators that means you have to cater for both interests. You give a concept where they can use a calculator and they work it out, then you give these ones with mathematical tables, then you work with them and see what they come up with… (T3-INT).

Meanwhile T4 reported that students at LP2 "have calculators, they have logarithmic tables, and we have in stock enough logarithmic tables as printed materials to cover each per student." Ironically, though these materials were reported as available students were not using them in the classrooms.

Table 5.1 Components of Teachers' Use of Classroom Environment in HP- and LP-Schools

COMPONENTS	HP-SCHOOLS	LP-SCHOOLS
Instructional Resources and Materials	-More resources and materials used; -School buys textbooks for students; -Students owned or shared textbooks e.g. SMEA; -Physical model and teaching aids used for teaching; -UNEB past papers booklets and school past papers used for exercises; -Logarithmic tables	-Few resources and materials used; -Students buy their own textbooks; -Students did not have textbooks e.g. SMEA; -Hardly any teaching aids used for teaching; -Teachers had no UNEB past paper booklets but used school past papers as a sources for problems - Logarithmic tables
Use of Technology	-More calculators available and used; -No computers in use	-Few calculators available and used; -No computers in use
Classroom Organisation	-Students occasionally arranged in traditional rows and columns; -Small group work organised	-Students predominantly arranged in traditional rows and columns

Classroom organisation

Classroom organisation refers to the arrangement and organisation of the classroom. The dominant classroom arrangement in all the study schools was students seated in traditional rows and columns facing the teacher. However, students were occasionally able to make contributions to class discussion either whenever called upon to do so or through individual initiation. During lesson observation at HP2, it was evident that the teacher would sometimes transform the rows and columns into working groups as the lesson progressed. In some of the lessons T2 taught it was confirmed that students would move to their neighbours or turn round to work with their neighbours to discuss their work, as he explained.

> There is even a moment that some (students) were going to the neighbours to ask this and that. There is that time when there can be some group somewhere, another group has formed that one, and another group is there (T2-INT).

In response to a question about whether grouping students was a regular practice in his teaching T2 claimed, "That is what always goes on here."

5.2.2 *Management of teaching*

In looking at the management of teaching in the various schools it was observed that teaching was differently managed in the HP- and LP-schools. Although teaching was differently managed there was no clear pattern that emerged that could be solely associated with the HP- or LP-schools. As Table 5.2 shows the size of the teaching force in each school, the class sizes, and the teacher deployment patterns were different. The teacher deployment patterns that emerged were the horizontal, the vertical and the ad hoc teacher deployment patterns. Lessons were also differently allocated to mathematics per week. It is quite clear that there were more mathematics teachers in the HP-schools than in the LP-schools. On average there was a higher teacher-pupil ratio in the HP-schools (1:45) than in the LP-schools (1:33). The teacher-pupil ratio was estimated from the average number of students in each class that was usually taught by one teacher. For example, the total number of students in the HP-schools was 90 students. Two teachers taught these students. On average each teacher taught 45 students that gives a ratio of 1:45. Similarly in the LP-schools there were a total of 67 students taught by the two teachers, and average that is 33 students per teacher.

In the horizontal teacher deployment pattern teachers taught at a particular level like S1, S2, S3 or S4 classes. In this case the teacher received new groups of students as members of the class each year. The horizontal management pattern was observed in LP1. At LP1 with only two mathematics teachers the horizontal teacher deployment pattern was used. Furthermore, T3 reported that "since I came here, they give me S3 and S4…now I am concentrating on with candidate classes." Similarly, the horizontal teacher deployment pattern was also used at HP2.

Table 5.2: Teaching Force, Class Size, Teacher Deployment Pattern and Lesson Allocation by School-type per School

School-type	School	Teaching Force	Class Size	Deployment Pattern	Lessons Allocation
HP-	HP1	14	50	Ad hoc	5/6
	HP2	6	40	Vertical	6/5
LP-	LP1	2	32	Horizontal	6
	LP2	3	35	Ad hoc	6

In the vertical teacher deployment pattern teachers progressed upwards with their group of students each year to the next class. The teachers in HP-schools argued that vertical teacher deployment ensures continuity of the teacher with the same group of students. They claimed that the teacher and the students get to know each other's strengths and weaknesses. In doing so appropriate action could then be taken to address any identified student weaknesses, because student weaknesses are not easy to detect when teachers are changed regularly. The vertical teacher deployment practice allowed the teacher to become familiar with the students, which in her study Civil (2002) found to promote learning between the teacher and students. Meanwhile at HP2, T2 reported that:

> In some other schools, there is a teacher called Maths teacher for S.1, Maths teacher for S2, Maths teacher for S3, what we do is, you teach students from S1 up to S4, the same group from S1, you keep moving with them...we have a system whereby you pick a stream from senior one, when they go to senior two, you move with them, senior three you are with them, senior four, you are with them… (T2-INT).

The ad-hoc teacher deployment pattern was practiced at both HP1 and LP2. In the ad hoc teacher deployment pattern both the vertical and horizontal arrangements were employed as found suitable by the teachers. The teacher could move or be moved vertically downwards from S3 to S2, or vertically upwards from S3 to S4 or the teacher could remain at the same level but change classes from S3A to S3B for example. At HP1, with 14 mathematics teachers a teacher could be switched horizontally at the same level. For example, T1 pointed out that any teacher could be moved to any class at the discretion of the head of department. As he explained:

> Like if you teach...if you are given 3B, you have to teach it until the end of the year unless there is a problem, you have to teach for the whole year. And may be you can continue with it or you may not. But in most cases teachers don't proceed with the class they have taught previously… [Researcher: Are teachers fixed to classes?] Not exactly, you may be changed. May be to senior one or to senior two, or you may continue with your students by the head of department (T1-INT).

Similarly, at LP2 with only three mathematics teachers the ad hoc teacher deployment pattern was used. According to T4 he reported that "normally, ah…if one handles ah…say S2A for one term, if one is interested in changing over, we just change over like that." The practice at LP2 appeared a laissez-faire way to handle teacher deployment.

In short, both HP- and LP-schools used either the vertical or the horizontal or the ad hoc teacher deployment pattern as the teachers felt fit. The teacher deployment pattern that would be adapted appears to depend on the number of mathematics teachers in the school and the departmental management style.

5.2.3 Planning and Preparation

Scrutiny of the data revealed two key issues that were central in the planning and preparation for teaching that emerged. These were the arrangement of teaching and the focus on completing the syllabus. Teacher planning and preparation refer to the activities that teachers conducted inside and outside the classrooms to prepare to teach. A summary of the teacher planning and preparation strategies are presented in Table 5.3.

Arrangement of teaching

Arrangement of teaching entails how the teachers conducted their teaching. The teachers in the HP-schools, especially those at HP2, organised synchronised teaching. Synchronised instruction entails teachers sharing ideas with colleagues on topics-content and their coverage, and attempting to cover the same topics and content concurrently. These teachers planned to teach similar content at the same time. They prepared common schemes of work together and set common test and examinations. The teachers in the HP-schools also re-ordered the topics in the textbooks and the syllabus to facilitate organised coverage. Synchronised instruction practice was more prominently practiced at HP2.

At this school the mathematics teachers liaised and consulted with each other regularly. As T2 expressed "we teach each topic together. When I am handling class 1B, somebody else is handling class 1C and another teacher is handling class 1A on the same topic." The synchronised teaching arrangement facilitated student peer interaction. Students had opportunity to share with their peers the work covered in other classes; they could seek clarification from one another what might not have been clear; and they could compare notes from different teachers. T2 attested to this synchronised teaching arrangement and its benefits by saying, "if we use synchronised instruction the students can swap work." Synchronised teaching was therefore supportive of uniformity and student collaboration within the school.

Meanwhile, according to T1 teachers at HP1 re-arranged some topics in the textbooks and syllabus that were covered over several years such as Statistics so as to offer it as a coherent content and have it finished off in a coherent way in one year. The swapping arrangement meant that some topics, which were covered at several levels, were completed at one level. He pointed out that, for example, with "statistics normally, we want to complete everything. Finish all the statistics theory. So that when students come to senior four they will only be solving problems." T1 put emphasis on the reordering of topics as was illustrated in the exchange between the researcher (R) and him in the following excerpt.

R: Is the statistics covered in S.2, S.3 and S.4 following the spiral approach?

T1: Oh ya. Statistics is in senior one, senior two, and three then four.

R: So how do you teach this particular topic?

T1: The statistics. Normally, we want to finish everything.

R: O.k. what do you mean?

T1: Finish everything. Finish all the problems. So that when it comes to senior four they will only be solving problems.

R: Uhm...So you sort of bring up everything together? (T1-INT)

A similar approach of re-ordering topics was also used at HP2. T2 expressed unhappiness with the way authors arranged topics in their textbooks. Basically topics were arranged in a spiral order with topics recycling almost annually. He claimed that a common observation was that some teachers tended to follow the textbook page by page, but the teachers at HP2 conveniently re-ordered the topics in the textbooks and syllabus as he explained.

> The way these series of textbooks we are using, like School Mathematics of East Africa, they have arranged the topics. We have found that it is not a very good order; it is not absolutely the right order. There are some topics, even present in Book 4 that a student in S1 can be able to follow than the one presented in Book 1. So what we have done…we have arranged those

topics in some order. Like you find that teaching statistics in senior one and two is very, very interesting… all the statistics the students know it very well. We have all the materials, teaching aids, we put them into groups, we do everything, at the end everybody in this school does that number [on statistics], if it is there in the examination (T2-INT).

Both T1 and T2 cited statistics as particularly suitable to re-organise, teach it in an interesting way, and could be used to connect mathematics to everyday life. In contrast, at the LP-schools the teachers taught in isolation and usually covered topics in the order in which they appear in the textbooks and/or syllabus.

Table 5.3: Teachers' Planning and Preparation Strategies.

STRATEGY	HP-SCHOOLS	LP-SCHOOLS
Arrangement for teaching	-Synchronised teaching -Similar coverage of content -Common schemes of work, tests and examinations -Re-ordered topics in textbooks and syllabus	-Taught individually -Covered content alone -Taught topics as presented in textbooks and syllabus

5.2.4 Diagnosis of student difficulties

All the participating teachers in this study from both HP- and LP-schools identified students with learning difficulties through diagnostic testing and using student achievement levels. In the HP-schools the teachers tested currently covered work using written and oral tests. For example, T2 identified students "who were not performing" according to his expectation as those with learning difficulties. At the same time the students' work showed areas that were not understood that needed more attention.

> When I give a paper like at the end of the year, you find certain questions on difficult topics have been dodged…but when the teachers are marking, they always discover problems where most students are not performing…these are the areas we need now to go into in detail in the syllabus coverage (T2-INT).

In a like manner, teachers in the LP-schools used revision tests that covered previous work done. A diagnostic approach of critically analysing students' work in order to detect students with difficulties in mathematics was used at the LP1. T3 extended the diagnostic approach to test, not only currently covered work but he also included previous years' work. He detected the sources of student weakness from the gaps that they left as unanswered parts of questions. T3 described his approach in the following words:

> I normally give them past-paper-questions from S.2 and say, try the questions you think you can. So you see somebody trying a number maybe on bases, a number on statistics part of it, and a number on maybe trigonometry, then she leaves out questions ah…concerning other chapters, that's when you can identify there is a problem there (T3-INT).

In the practice of diagnosing student difficulties, "assessments…furnish[ed] useful information to both teachers and students…[that was applied] to improve mathematics instruction" (NCTM, 2000:572).

The teachers in HP-schools used achievement levels to identify weak students who needed help. They also used various methods and techniques to determine students' difficulties like through identifying students' lack of understanding and misconceptions. For instance, T1 said he used written tests and oral questioning to isolate students with mathematics learning difficulties, as he described:

> You can give an exercise or you can give the students a test, and from there you can see from the marks…okay, if you ask a question and they begin to answer when they are not sure they begin asking questions what he is not sure, when he is not sure (T1-INT).

Meanwhile, teachers in the LP-schools identified the topics that need attention as those problems students did not attempt in the exercises. The techniques that the teachers used in the HP- and LP-schools are summarised in Table 5.4.

Table 5.4: Techniques of Diagnosing Student Difficulties by School-type

TECHNIQUE	HP-SCHOOLS	LP-SCHOOLS
Diagnostic Testing	-Written tests -Oral tests	-Revision tests
Achievement Level	-Identify weak students -Through Feedback	-Topics not attempted

5.2.5 Instructional approaches

The observations and interviews with the teachers in the study revealed that they used several instructional approaches. The instructional approaches were taken to mean what teachers did to engage students in their classrooms as shown in Table 5.5. The study revealed that teachers adjusted their teaching approaches to suit student needs through tailored teaching, providing wait-time and expository teaching.

Tailored teaching

Tailored teaching *involves* adjusting teaching to suit the level and needs of the students. It was observed that teachers used tailored teaching in both HP- and LP-schools to entice students to have interest in their work and promote their achievement in mathematics. For instance, at HP1 when T1 taught mathematics using examples from everyday issues, he also declared he adjusted the teaching speed accordingly to strike a balance between coverage of work and understanding of the concepts. He reported that:

> Because we want to finish the syllabus, we tend to go fast on some topics, which would need to go slow, or we can be faster in order to cover much…so we have to strike a balance. The students understand you, and we also try to cover the whole syllabus…I come when I am prepared and I use local or common information and everyday things that happen that are related to mathematics…I use local examples to illustrate a point…What you normally aim at teaching, at least you should have something, either a teaching aid or a demonstration or some illustrations. This is very instructive. But if you just come and talk then you even fail to correlate what is happening in the world and mathematics (T1-INT).

Similarly at LP2, T4 was aware of students' low ability and the nature of the students he was teaching, at least according to his expectation. He therefore took appropriate precautions to plan appropriate slow paced lessons for the classes he taught because he conceptualised his students as academically weaker:

I don't normally push [them/students], because of their ability, you know they are a low achievement group, so normally I go…I introduce one concept after another, slowly, step by step, so that eventually when you bring in, like the wording, it becomes part of the literature…I centre much of the discussion, as I introduce the concepts, I centre much of the discussion on the people listening, the learners (T4-INT).

Table 5.5: Instructional Approaches used in HP- and LP- Schools

APPROACH	HP-SCHOOL	LP-SCHOOL
Tailored teaching	*	*
Provided wait-time	*	X
Expository teaching	*	*

Legend: * = Practiced; X = Not practiced.

Wait-Time

Wait time refers to the time that students are given to think over an issue, a question or an answer before they respond. In HP2 the teacher acted as a facilitator of learning. He gave students time to think, to interact and to share their thoughts with the other students before he intervened. As he explained:

Ok, the way I have been conducting my other lessons, I always have to have time, when I give a question to S3s, I must give them time to think, discuss amongst themselves before I should expect the response. So that kind of time should be always there. So after even getting the response, in most cases students should be given the chance to answer. They should be given chance to explain to their fellow friends before you the teacher can bring firm judgment on what they are discussing and put the ideas straight, across to them (T2-INT).

The lessons at HP2 tended to be student-centred. However, teachers in the LP-schools provided no such wait-time to their students during the teaching.

Expository teaching

Expository teaching refers to teacher-dominated talking, explaining and telling students the mathematics content. Both in HP- and LP-schools expository teaching was practiced, though teachers in the HP-schools were more flexible of their approaches than those in the LP-schools. Teachers in the LP-schools tended to be rigid to teacher-centeredness. For example, T3 approached his teaching by using the blackboard to write the key points and worked examples of problems of his lessons. As T3 explained, "all my questions which I give, the basics are normally the ones I give, which are on the blackboard." At the same time, T3 used past-paper-questions collected from other schools to direct his teaching, in order to cover earlier uncompleted work. He used the past-paper-questions to browse through the work that the students had not covered as he explained:

> What I normally do is, because now I have access to the other side (another school)…the question papers, we have question banks there and I am in-charge of them. So, what I normally do, I bring them, normally in senior three…if what they lost was in senior two… (T3-INT).

In sum, the teachers tailored their teaching to the type of students they saw they had and to the teacher's own teaching style and their expectations. The teachers in the HP-schools gave opportunity for students to make contributions and to think. But the teachers in the LP-schools mainly taught teacher-centred lessons.

5.2.6 Additional teaching sessions

Additional teaching sessions were organised in all schools at times outside the official class time. The additional teaching sessions involve giving more engagement time to the students outside the official contact time to advance student learning. The organisation of additional teaching sessions varied according to (1) the contact time; (2) the school policy; and (3) the goals of the additional teaching sessions as summarised in Table 5.6.

Table 5.6: Aspects of Additional Teaching Sessions in HP- and LP- Schools

ASPECT	HP-SCHOOLS	LP-SCHOOLS
Contact time	-Preparatory time (Night) -Lunch and/or Tea break -Library Periods -After School -By time arrangement -Weekends (Sat. or Sun)	-Early Morning -Free time -By time arrangement -During Holidays - Weekends (Sat. or Sun)
School Policy	-Encourages Teaching sessions -Incentives provided	-No policy -No incentives -Voluntary Service
Goals	-Maintain Content Coverage -Provide more assistance to students with difficulties -Re-teach what was not clear and not understood -Complete the Content in the Syllabus	-Catch-up with uncompleted Content -Provide Revision - Re-teach what was not clear and not understood -Answer Students' Problems - Complete the Content in the Syllabus

Contact time

Contact time refers to the time that the teacher and the students held face-to-face teaching sessions. The additional teaching sessions were organised at different times. Both HP- and LP-schools used weekends and specially arranged times to conduct additional sessions. For example, at HP2 additional teaching was conducted either after school or over lunch break or at the weekend as T2 explained.

> We normally take time to explain to them at lunch break. Because the lunch break is from 12.45 up to 2.00 pm and it is long enough…and you heard them say Saturday, because I normally meet them sometimes on Saturdays (T2-INT).

But, at HP1 additional teaching was conducted during the night study time, which was convenient for them as a boarding school or during the weekend. As T1 pointed out:

> O.k., we identify their problems and we arrange extra time for them, we call it 'remedials', during...may be after classes or weekends or it is after classes or at the weekends or we can even decide to come during preparation time, i.e. from 8- 9 or 10.30 pm. (T1-INT).

Similarly, T3 said, "what I normally do is I have remedial lessons for each class I give those two weeks, two Saturdays in a month. But, the additional teaching sessions services were more or less voluntary, for there were no incentives attached" to them. The additional teaching sessions were basically free, but they showed the personal commitment of the teachers involved.

There were other different times for additional teaching at the LP-schools. For example, T4 reported of a tradition at LP2 that they "enter the holiday days by one week, to recover the first week which is always lost" due to the poor turn up of the students at the beginning of the term due to non payment of fees. But in the course of the term every available free time on the timetable, referred to as library periods, was utilised as well as the time before normal morning lessons start. Such an arrangement involved teaching during the holidays for the students who could attend. Unfortunately those students who could not attend the holiday sessions missed out the work.

> Library period, if I don't appear before them, they will discuss…students will be meeting during that time and they discuss. Two, we have preparation time, preparation time, normally is the first thing in the morning, ah… about forty or forty-five minutes in the morning, so normally they exploit that also… during holidays they go with the work (T4-INT).

Furthermore, T4 indicated that they offered additional teaching sessions during free time or during periods that are created to try to cover uncompleted work:

> What happens is we always create remedial lessons in free periods…so that the work that is kept pending…is normally compensated for during those remedial periods, which we create within term and at times holiday… (T4-INT).

Any content that is not taught during normal school time is kept as pending. Such work would later be taught if time is found such as during free periods.

General School Policy

The general school policy refers to the accepted, encouraged and promoted practice of the school that relates to administration and the implementation of the curriculum. In the HP-schools the additional teaching sessions were a policy issue and teachers were remunerated for participating in teaching additional sessions. These additional teaching sessions were often referred to as 'remedials'. For example, at HP1 it was the school's policy to conduct additional teaching sessions. In contrast, in both LP-schools there was no such school policy on additional teaching sessions. As a result teachers were not paid for extra teaching as intimated earlier in the previous section. Furthermore, T1 indicated that teachers at HP1 were given monetary remuneration as incentive for additional teaching. "We get some money for the extra work we have done, that is for 'remedials' specifically...." This was also the case at HP2. Although additional sessions were similarly offered at the LP-schools they were not paid for. At LP1, T3 said, "What I normally do is I have remedial lessons for each class....But [in contrast], these services are more or less voluntary, for there were no incentives attached." Likewise at LP2, T4 reported that they offer additional teaching sessions.

Goals for additional teaching sessions

The additional teaching sessions appeared to serve several functions. The goals for additional teaching sessions concerned the reasons for, purposes of, and the intentions of the additional teaching sessions. The additional teaching sessions were organised for different reasons and served several functions, which were quite similar in HP- and LP-schools. For example, first the arrangements and the organisation of additional teaching sessions at HP1 was to ensure that the students did not fall behind and to improve their understanding of what was taught. As T1 explained:

> What we do…we go through the work we have just covered in the previous lesson or lessons, which they did not understand. That is how we can bring them up (T1-INT).

The goal of ensuring that students do not fall behind at HP1 was similar to that at LP2, where the additional teaching sessions were used to cover uncompleted work. T4 stated, "During those extra periods we are talking about, we catch-up" with unfinished work. "Catching-up" is taken to mean compensating for time that was lost by teaching uncompleted work at that time.

Second, both types of schools also taught additional sessions to re-teach what was not clear and not understood. For example, at HP2 the additional teaching served to provide extra work for students who experienced difficulties in certain topics. It was also an avenue to resolve difficulties students experienced in the study groups, which we shall talk about in the next section, as T2 explained:

> There are those [students] who get problems in the topics. I give them extra work, that do this then…you mark, and explain." They are in their groups meeting. They get the problems…they will forward to me. And they say that 'Teacher in group this, we had this problem and nobody could do it, or explain it, in the group…can you help us. So I now go there when I know that they are actually defeated. There is nobody in the group who could do, or in the class actually generally (T2-INT).

Third, at the LP-schools the additional teaching sessions were organised to clarify or re-teach what students had covered but they had not understood at a slower pace. For instance, in the case of LP1, T3 explained:

> So, what I normally do is, I have remedial lessons for each class, that's where you can ask them before you end the week, which chapter among the ones you've covered, they think wasn't very clear. So that when you are coming on Saturday you prepare for that work (T3-INT).

Fourth, additional teaching sessions were organised in both the HP- and LP-schools to try to cover untaught work so as to try to complete the content in the syllabus.

From these excerpts and quotations the teachers seemed concerned with the learners being up-to-date all the time, attempted to cover what was not understood, taught uncovered work in the syllabus and clarified on what was not understood. And teachers put in extra effort to get through additional lessons at various times and different intentions. Additional teaching sessions were conducted in all schools mainly to re-teach what was not clear and not understood; to catch up with delayed syllabus coverage; and to improve on the student performance.

5.3 ENHANCING PARTICIPATION

Enhancing Participation deals with what teachers do and say in order to improve student attitudes towards mathematics and engage students in the learning process. It thus deals with the question: What do mathematics teachers say about their instructional practices in mathematics classrooms in the HP- and LP-schools?

The findings of this study indicate that the teachers tried to improve student attitudes towards mathematics and promote participation through paying attention to: (1) the teacher engagement and behaviour; (2) the teacher-student interaction; (3) the student engagement during lessons; (4) the teacher conceptions and attitudes about students (5) the student grouping strategies; and (6) the assessment and evaluation; and presentations of lessons. These findings are discussed below and are summarised in Tables 5.7, 5.11, 5.12 and 5.13.

5.3.1 Teacher engagement and behaviour

The teachers in the HP-schools modelled participation in their practices. There were regular peer collaborations between the teachers. The teachers regularly held both formal and informal meetings to discuss their work. They conferred with each other as peers outside the classroom at different times such as over tea-break and at lunch-time in the staff room or other suitable places. In the interviews the teachers reported that peer consultation was their mode of practice and operation. Another thing that these teachers did was they taught from a common scheme of work and teaching syllabus, which was available, and they showed the researcher. At the same time, these teachers compared and closely followed the syllabus coverage. Each teacher taught the same topic simultaneously in the different classes at the same level. For example, in HP1, T1 narrated their practice as follows:

> Yes, yes…ya…. What we do, we make a common scheme of work, then we operate through agreement that by this time we shall have covered this and set a common test for all S.3 students…we also hold planning and evaluation meetings at the beginning and end of the term…we sit and agree to ourselves, how far have we gone? Have we finished the syllabus? And how are the students? Like that and like that… (T1-INT).

Similarly, at HP2 the teachers met to share their experiences, discuss their teaching approaches and made arrangements and to monitor their own work so as to plan how to actively engage the students. T2 explained their practice as follows:

> Very often, in fact we meet almost daily. There is a group that meets daily, that is if you are maths teachers teaching in S.1, you meet everyday to check on your coverage. How you are getting on with your stream… some sections may be easier for one colleague and another may find it difficult. So the colleague will be able to give guidelines on how to introduce the topic and how to handle it when you are in class (T2-INT).

On one of the visits to HP2, the mathematics teachers were observed solving a past paper problem, that had been given to the students as an exercise, during the lunch break.

Meanwhile, the teachers at the LP-schools reported that most of the time they worked in isolation and used individual schemes of work. They held only formal meetings to sort out administrative chores and plan for the term's work. These teachers only consulted with each other to help each other out of an academic problem. Occasionally they also met to share ideas and plan line-of-attack for the content of the problem areas. Although the teachers in the LP-schools appeared to be doing the same things as the teachers in the HP-schools, because the data are not very rich the key similarities did not clearly come through. For example, T3 explained the practice in their school that "you normally refer to a colleague whenever you think things are not very comfortable with you, a friend can only come in and help." Although the expectation is that with the small teaching force at the LP-schools it would be easier for them to meet and consult with each other. On the ground, this was not the case as there was not much teacher interaction in the LP-schools.

In a similar manner, T2 reported that they discussed among themselves the teaching methods and how each one found the topic being taught "because with us teachers we also have different abilities." He further reported that all the mathematics teachers taught the same topic simultaneously for all the three streams of S.3. The teachers worked cooperatively through peer conferring to facilitate student discussion inside and outside of the classroom. The teachers' engagement and behaviour activities derived from the interview transcripts data are summarised in Table 5.7 for the HP- and LP-schools.

Table 5.7: Activities for Teacher Engagement in HP- and LP-Schools.

HP-SCHOOLS	LP-SCHOOLS
ACTIVITIES	**ACTIVITIES**
-Have peer consultations -Use a common scheme of work -Hold formal and informal meetings -Discuss teaching approaches -Always conduct joint testing and marking	-Work individually -Use individual schemes -Hold formal meetings -Consult each other on difficult areas to teach -Each teacher tests independently during term -Conduct joint testing at end of term

5.3.2 Teacher-Student interaction: Flanders' Interaction Analysis

This section describes the coding of the lesson observations using Flanders Interaction Scheme. The tape-recorded lessons were played back and coded into a Flanders Interaction Analysis Categories (FIAC) sheet as illustrated in Table 5.8. The full coding sheet is included in Appendix H1. A code was entered for every five seconds of lesson segment (rather than three seconds used by Flanders (1970)). The three-second period proved too short to pick any changes in lesson activities. The code numbers entered into the coded table corresponded to the 10 Flanders interaction categories as in the Flanders Interaction Analysis Categories given in Figure 3.2. The whole classroom interaction was divided into 10 Flanders interaction analysis categories. For example, in Table 5.8 during the first minute the first five interactions were coded 0 = silence or confusion (zero was used for category 10), 6 = giving directions, 5 = lecturing, 4 = asks questions, and 8 = pupil-talk response. The code categories that the observer recorded were then tabulated and encoded into a 10 x 10 matrix table as illustrated in Table 5.9 for the LP-schools. The full 10 x 10 matrices are given in Appendix H2 which was collapsed for (a) the HP-schools and (b) the LP-schools. The rows of the 10 x10 matrix were named one to 10 from top to bottom on the left side of the page. The columns were named one to 10 from left to right at the top of the page. In filling the 10 x 10 matrix the sequence of the coded numbers from the coding sheet were then taken as a continuous string of numbers and grouped into overlapping sequence-pairs. These pairs of numbers were then tallied onto the 10 x 10 matrix. For example, the sequence pairs for the last 15 seconds of the first minute and the first 20 seconds of the second minute of Table 5.8 were coded as: (4-8), (8-7), (7-8), (8-2), (2-4), (4-0) and so on. The cell for a pair of numbers was indicated by the intersection of the first number as the row and the second number as the column. For instance, the tally for the pair (4-8) was placed in the row-four and column-eight cell.

Table 5.8: Sample of Flanders Interaction Analysis categories Coding Sheet.

Time/ Min	***CATEGORIES***											
1	0	6	5	4	8	8	2	5	5	**4**	**8**	7
2	**8**	**2**	4	0	0	4	5	4	8	8	9	2
3	…											
4												
5												
.												
.												
.												
40												

After tallying all the interaction pairs, an Arabic numeral was entered in each cell to represent the frequency of occurrence of that pair of numbers which gave the cell loading of the pair in the matrix as shown in Table 5.9. Consider again the pair (4-8) in Table 5.9 that pair occurred 234 times. This means that 234 times the teacher asked questions (code 4) was followed by pupil-talk response (code 8) during the observation. In contrast, the pair (8-5) cell-loading mean that pupils-talk response (code 8) followed by lecturing (code 5) occurred 90 times.

Table 5.9: Sample Flanders Interaction-Matrix for the LP-Schools.

Cat.	1	2	3	4	5	6	7	8	9	10	Tot
1	0	0	0	0	0	0	0	0	1	0	1
2	0	6	1	6	6	15	2	3	0	2	41
3	0	0	17	6	8	1	0	6	0	0	38
4	1	0	0	98	10	1	3	234	1	22	370
5	0	2	0	116	1088	27	1	4	5	27	1270
6	0	1	0	30	23	291	1	10	1	38	395
7	0	0	0	6	12	4	15	0	0	6	43
8	0	29	19	73	90	21	16	240	4	14	506
9	0	0	1	4	6	2	0	1	18	0	32
10	0	3	0	31	27	33	5	8	2	555	664
Tot	1	41	38	370	1270	395	43	506	32	664	3360
%	.03	1.22	1.13	11.01	37.80	11.76	1.28	15.06	.95	19.76	100.0

In order to interpret the 10 by 10 matrix Flanders suggested five steps namely:

1. Estimating the elapsed coding time using matrix totals;
2. Checking the percentages of the teacher talk and student talk and silence or confusion;
3. Checking the balance of teacher response and initiation with student initiation;
4. Checking the initial reaction of the teacher to the termination of the students' talk;
5. Checking the proportion of tallies found in the "content cross" and "steady state cells" to estimate the rapidity of exchange tendency towards sustained talk and content emphasis. (The content-cross cells are the cells that lie within the columns and rows of categories 4 and 5. The steady-state cells are the cells that lie within the ten leading diagonal cells).

In this study the classroom interactions were analysed using the dimensions: the proportion of teacher-talk, student-talk and silence and confusion; the balance of the teacher's response-initiative to student initiation; the teacher's reaction when the students stop talking; and the emphasis given to the content and sustained expression were presented in the same category.

It is noteworthy to remember that the FIAC system does not capture the total classroom activity. The FIAC system was limited to teacher talk, student talk and silence or confusion. The description of the teacher classroom interaction behaviour could be used for evaluating teachers and their activities but was not done in this study. Also the FIAC system is content-free and the lesson content therefore was not investigated.

The classroom interactions were analysed by considering the amount of time involved in the observation. The amount of time involved was derived from the matrix totals in the interaction matrix. The coding rate was equal to the coding time in seconds divided by the matrix totals. The proportions of teacher-talk, student-talk and silence and confusion were found by converting appropriate columns totals in the interaction matrix to percentages of the total.

The interaction matrix was then built as follows:

1. The code categories that the observer recorded were tabulated and encoded into a 10 x 10 matrix table as shown in Appendix H2 for the HP- and the LP-schools.

2. The numbers recorded by an observer start and end with the same code number. If the numbers at the start and end were not the same code then a zero was added at the start and the end of the sequence.
3. The sequences of coded numbers were grouped into overlapping sequence-pairs that were then plotted onto the 10 x 10 matrix. The cell for a pair of numbers was indicated by the intersection of the first number as the row and the second number as the column. For example, the tally for the pair (4-8) was placed in the row-four and column-eight cell. As a quick check, the number of observations (N) would need N minus one (N-1) tallies in the matrix.
4. After the tallying an Arabic numeral was entered in each cell to represent the frequency of occurrence of that pair of numbers as its cell loading.

The Flanders interaction analysis of the audio taped lessons yielded patterns of activities that teachers engaged in during their lessons. The analysis of audiotapes triangulated the information that was captured through the LOP. The classroom interaction was analysed using the following dimensions: (1) the proportion of teacher-talk, student-talk and silence and confusion; (2) the balance of the teacher's response-initiative to student initiation; (3) the teacher's reaction when the students stopped talking; and (4) the emphasis given to the content and sustained expression were presented in the same category. The analyses were compared to the eighth-grade values because the students studied would probably have closer characteristics to eighth-grade than the twelfth-grade students.

Proportion of teacher-talk

The total percentage of teacher-talk was found from the teacher-talk categories one to seven frequencies. Dividing the sum of categories one to seven by the grand total and multiplying the quotient by 100 determined the amount of teacher-talk (TT). The percentage of pupil-talk (PT) was found by dividing the sum of the categories eight and nine by the total number of tallies in the whole matrix and multiplying the quotient by 100. Dividing the category 10 frequencies by the total number of tallies in the matrix and then multiplying the quotient by 100 found the percentage of silence or confusion.

A simple ratio based on two matrix totals increased or decreased the entries in an appropriate matrix by a suitable proportion. The normative expectation of teacher-talk for grade eight mathematics classes is 70 percent; the normative expectation of pupil-talk is 19 percent, and the normative expectation of silence and confusion is 11 percent (Flanders, 1970). The Table 5.10 shows that the percentage of teacher-talk (TT) is higher in HP-schools (70.1%) than that in LP-schools (64.2%).

Teacher's response-initiative to pupil initiation

The balance of the teacher's response-initiative to pupil initiation is a mutual relationship between the teacher and student statements, that is, "the more a teacher takes initiative the more likely the students are to respond and the more a teacher responds the more likely it is that students will make statements which show initiative" (Flanders, 1970:110). A quick comparison between the balance between initiation and response was calculated from any of the three ratios: (1) the teacher response ratio (TRR), or (2) the teacher question ratio (TQR), or (3) the pupil initiative ratio (PIR).

The TRR is an index, which corresponds to the teacher's tendency to react to the ideas and feelings of students. It was determined from the categories 1, 2, and 3 frequencies by dividing their sum by the sum of the categories 1, 2, 3, 6, and 7 and then multiplying the quotient by 100. The normative expectation of TRR was 35 percent for eighth-grade mathematics. The eighth-grade normative expectations were given to provide a feel of the values previously derived through research at a level lower than the level studied which could be comparable.

The TQR is an index representing the tendency of a teacher to use questions when guiding the more content oriented part of the class discussion. It was found from the category four frequencies by dividing the category 4 frequencies by the sum of the categories 4 and 5 and then multiplying the quotient by 100. The normative expectation of TQR was 20 percent for eighth-grade mathematics.

The PIR indicates the proportion of the pupil-talk that was judged by the observer to be an act of initiation. It was found from the category nine frequencies by dividing the category 9 frequencies by the sum of the categories 8 and 9 and then multiplying the quotient by 100. The normative expectation of PIR was 35 percent for eighth-grade mathematics. There was higher PIR value in the HP-schools (19.3%) than in the LP-schools (5.9%), which were lower than the normative expectation at the eighth-grade level.

The teacher response ratios (TRR) in both types of schools were low. The TRR for teachers in the HP-schools (16.3%) was slightly higher than for teachers at LP-schools (15.4%). The teacher question ratios (TQR) in both types of schools are quite high. The teachers' TQR index in the LP-schools is higher than for teachers at the HP-schools.

Teacher's reaction when the pupils stop talking

The teacher's reaction when the students stop talking can be found from the cells in which either a student stops to talk and a teacher starts to talk, (these are the combination of 8 and 9 row codes with the one to seven column codes). Alternatively the last thing a teacher says before a student begins to talk, (which are the combination of one to seven row codes with the 8 and 9 column codes). The instantaneous teacher response ratio (TRR89) or the instantaneous teacher question ratio (TQR89) can be calculated. The TRR89 was defined as the tendency of the teacher to praise or integrate student ideas and feelings into the class discussion at the moment the students stopped talking. It was found from the sum of categories 8 and 9 rows and 1, 2, and 3 columns frequencies divided by the sum of the categories 8 and 9 rows and 1, 2, 3, 6, and 7 columns and then multiplying the quotient by 100. The normative expectation of TRR89 is 67 percent for eighth-grade mathematics. The TRR89 ratio for teachers in HP-schools (60.7%) is higher than for teachers in the LP-schools (55.7%).

The TQR89 is the tendency of the teacher to respond to pupil-talk with questions based on his/her own ideas, compared to his/her tendency to lecture. It was calculated from the cells frequencies by dividing the sum of the categories 8-4 and 9-4 cells by the sum of the categories 8-4, 8-5, 9-4 and 9-5 cells and then multiplying the quotient by 100. The normative expectation of TQR89 is 39 percent for eighth-grade mathematics. The teachers' immediate question ratios (TQR89) in both types of schools are moderate 48.2% in the HP-schools and 44.5% in the LP-schools.

Emphasis on content coverage

The emphasis given to the content and how much sustained expression was present in the same category was found from (1) the content cross ratio (CCR), (2) the steady state ratio (SSR) or (3) the separate pupil steady state ratio (PSSR). The CCR is the percent of all tallies that lie within the content cross. The higher the CCR the more focused the class discussion was to the subject matter. The Flanders (1970) interaction analysis revealed that more than 50 percent of the time was spent on emphasizing the content in both types of schools 63.1% in HP-schools and 58.6% in LP-schools as shown in Table 5.10. The normative expectation of the CCR is 68 percent for eighth-grade mathematics classrooms.

The SSR is the percent of tallies that lie within the steady state cells. This reflects the tendency of the teacher and the students' talk to remain in the same category longer than the length of the coding time. The SSR in the types of schools were similar 70.4% in the HP-schools and 69.3% in the LP-schools.

The PSSR is an index that is sensitive to the rapidity of the teacher-pupil interchange when the pupil-talk is either average or above average. It was calculated from the cell frequencies by dividing the sum of the categories 8-8 and 9-9 cells by the sum of the 8 and 9 columns frequencies then multiplying the quotient by 100. This was taken as students' sustained discourse. The normative expectation of PSSR is 26 percent for eighth-grade mathematics classes. Content coverage was a strong feature that drives teacher actions. The analysis outlined in the previous sections are summarised into Table 5.10 for the data from LOP.

Table: 5.10 Matrix comparisons of various Teacher and Student Ratios for HP- and LP-schools.

		SCHOOL-TYPE	
VARIABLE	**SYMBOL**	**HP**	**LP**
Percent teacher talk	TT	70.1	64.2
Percent pupil talk	PT	14.9	16.0
Percent silence or confusion	SC	15.0	19.8
Teacher response ratio	TRR	16.3	15.4
Teacher question ratio	TQR	20.4	22.6
Teacher immediate response reaction	TRR89	60.7	55.7
Teacher immediate question ratio	TQR89	48.2	44.5
Pupil initiation ratio	PIR	19.3	5.9
Content emphasis	CCR	63.1	58.6
Total sustained discourse	SSR	70.4	69.3
Pupil sustained discourse	PSSR	49.7	48.0
Total of composite matrix	N	4200	3360
Number of teachers observed	N	2	2

5.3.3 Student Engagement during Lessons

During the lesson observations for T2 he consistently invited his students to communicate their ideas to the rest of the students in the classroom. While doing so he was patient with students of different characteristics. He never gave up encouraging the shy students to make contributions. T2 encouraged and counselled the students. The students too seemed to have gained more confidence and participation in activities increased. T2 explained his encounter with his students.

> It took me time to always call them in front to explain. Some could actually know the concept very well but they go and hide within themselves. They can only put up their hand for you to mark, so you ask them to explain to the friends, they shy away. Then there are those, even when they have the idea, they don't want, they are trembling. They fear completely. So I had to talk to them, give them the encouragement until now, whoever has a slight idea even if she is not sure of the rest of the working, will go to the blackboard. She wants to be corrected there (T2-INT).

Furthermore, according to T2 learners should actually be made to know that mathematics is a subject within us. Everyone should be able to build it within themselves and discuss it. People should hold the belief that there are few people superior in mathematics than others. Clearly people have different abilities, of course, abilities are not the same but everyone can get something in mathematics.

> It is not totally true that some students are called 'disadvantaged' completely in the subject [Mathematics]. I normally challenge my students by telling them, if you can get 80% in History, can't the same brain that accumulated those facts score for you say, 50% in mathematics, if well utilised with all the interest? And they can laugh and look at me. But I tell them, yes, compare the time you take to work, sit, read and get all the points that score for

> you a D1, a very good 1 in an Arts subject or the subject you feel is easier for you, can't you organise your brains and get the average marks in the other subjects. You find everybody says, 'it is possible, teacher, it is actually possible'. Then I tell them 'what is now left? Let us work together. By the time they reach senior four and you are revising anything, you actually enjoy a lesson and to be there in that lesson (T2-INT).

In addition to the use of words of encouragement and the active participation of the students by students coming to the blackboard to present their work to the rest of the students they were given written work. The solutions to the written work exercises formed the starting points for further discussion in the class. The discussion was usually led by one of the students. The shy students were also invited to do examples on the blackboard. But, according to T2 instead of telling students what to do I say: "Can I have somebody who can do the number on the blackboard?" T2 captured his practice in the statement.

> Apart from talking; I give them exercises to do. And once they are able to do, like this one who brought this work, any problem on the topic in the exercise, I ask her to come and present to the rest. When she is able to present correctly that is when you see them clapping. I tell them to always appreciate the effort of whoever has done something. So everybody thinks she can try (T2-INT).

In contrast, at the LP1, T3 advised his students to stick to the 'basics' which he would have written on the blackboard. Apparently the students' engagement was then reduced to attempting to solve new problems by copying and comparing the approach students applied with the one the teacher used on the blackboard for a similar problem.

> I normally advise, can you now, because all my questions which I give, the basics are normally the ones I give, which are on the blackboard...can you go and look at how we went through the question on the blackboard, and then relate it to which question I have given you and see whether you can run through, just for comparison, which is the only battle I normally have (T3-INT).

Another thing that teachers provided at HP2 was wait-time to allow students to engage in mathematical activities. For example, T2 allowed students time to think as he listened to their contributions. In allowing for wait time the teacher facilitated learning. He encouraged and engaged in discussion with students where he made contributions when it was necessary. But very often he held his opinion and judgement on an issue to the very end of a discussion. T2 further argued that although the timetable may not allow good discussion in the class, discussion must be held because ideally mathematics educators advocate that mathematics teaching requires student-led-small-groups in the same class while the teacher moderates the discussion.

> I always have to have time, when I give a question to S3s, I must give them time to think, discuss amongst themselves before I should expect the response. So that kind of time should be always there. So after even getting the response, in most cases students should be given the chance to answer. They should be given chance to explain to their fellow friends before you the teacher can bring firm judgment on what they are discussing and put the ideas straight, across to them. The idealist people will tell you, mathematics teaching needs small groups and the students within the same class should head these groups and the teacher supervises their discussion (T2-INT).

5.3.4 Teacher Perceptions and Attitudes about Students

The teacher perceptions and attitudes about students refer to the teacher's reflection about the nature of their students, their thinking of the student behaviour, and why they think the students perform the way they do. The teachers' views were derived from answers to the question "What are the characteristics of your students?" Teachers in HP- and LP-schools had various perceptions and attitudes about their students. The perceptions that the teachers had partly shaped the way they conducted their lessons. Almost in all cases the teachers perceived the way they taught to be determined by the student attitudes, the criteria that were used for admitting students, the primary school background of the students, the students' ability to communicate with the teacher and with the other students, as summarised in Table 5.11.

The teachers in the HP-schools perceived their students as having positive attitudes towards mathematics. The students were confident about and enjoyed mathematics. For example at HP2, their teacher claimed that:

> Most of the students have good positive attitude towards mathematics... Their confidence is just as I told you when you were coming that it is this term that the girls are enjoying every lesson of additional mathematics, because everyone has discovered that the subject that everyone was saying is difficult is actually doable.... And once they are able to do, like this one who brought this work, any problem on the topic in the exercise, I ask her to come and present to the rest. When she is able to present correctly that is when you see them clapping. I tell them to always appreciate the effort of whoever has done something. So everybody thinks she can try (T2-INT).

Table 5.11: Teacher Perceptions and Attitudes about Students in HP- and LP-Schools

School-type	School	Attitudes	Admission	Background	Freedom
HP-	HP1	Positive	The best grades admitted	From Urban best primary school	Easy communication
	HP2	Positive, willing to learn	The best grades admitted	From Urban best primary school	Free, confident
LP-	LP1	Negative attitudes weak at mathematics	Medium and bottom grades	From Rural medium primary school	Reserved, fear teacher
	LP2	Negative attitudes	Medium and bottom grades	From Rural medium primary school	Limited freedom

Similarly, at HP1, T1 expressed the same sentiments about their students having positive attitudes towards mathematics:

> Ok, they like the subject [Mathematics]...they are interested in it...and have a positive attitude towards the subject...some students experience difficulties...the very bright ones are in a separate [accelerated] class (T1-INT).

In contrast, the teachers in the LP-schools perceived their students as having negative attitudes, weak at mathematics, and the students were of either average or below average standard of achievement. For instance, according to T3 their students had negative attitudes towards mathematics. T3 described their students as:

> As you have seen, the participating level has been on a few individuals and majority, in that class of thirty-two students, you have about ten, who are very active and those are the ones, who after covering chapters, they come to you and say, please, can you give us, may be twenty problems and we try on ourselves and then we see what follows, but others, we have the biggest number, … actually (T3-INT).

The student admission criteria to all secondary schools are the same. But, the grades of students admitted to the HP-schools are usually better than the grades for students admitted to the LP-schools. The students with *distinction* passes (1 or 2) were admitted to the HP-schools, while students with *pass* passes (7 or 8) or sometimes even a *fail* (9) could be admitted to an LP-school. In general, students in the LP-schools had poorer grades at admission. T3 claimed that sometimes the admission criteria were watered down to accommodate the weakest of the weak students. The students in the LP-schools, at LP2 were similar to those at LP1 in many respects. According to T4, the students they admit "are not the best students" either.

Furthermore, the students admitted at the HP-schools usually come from "good" primary school background. Most of these students would have attended the best ranked primary schools in the country. The best primary schools were located in the urban centres. Such schools were usually well resourced both in material and human resources. On the contrary, the students who got admitted in the LP-schools were likely to have attended primary schools in the medium to poor performance range. Such primary schools were usually located in the rural setting. The rural primary schools often lacked resources for teaching. The students who were admitted for secondary education from such schools were generally with weaker primary mathematics background.

According to the teachers in the HP-schools their students had a good command of the English language. English is the medium of communication in the classrooms. As such, the students were able to fluently communicate with their teachers and with other students. At the same time, the students were free and confident to express themselves and their ideas. The students at HP2, for example, were very confident and felt free to express themselves among themselves and to the teachers. These students were able to freely present their work to be audited by the teacher and other students. On the other hand, the students in the LP-schools appeared reserved. They tended to fear their teachers and they did not freely speak, probably for fear of making grammatical mistakes. Consequently these students had limited freedom to express themselves to their teachers and to their peers in English. Most of these students preferred to communicate in the local linguistic dialect of the area. Probably their primary background and the local environment could partly explain the poor mathematical language the students seemed to have difficulty with. T4 seemed convinced that there are multiple sources of their students' problems as he explained:

> This is as a result of the intake, normally the bright students do not prefer to come to the rural areas as the term is on, but all the same, we do our best and ah…bring the extra lessons…we find that a good number come out, and we like ah…taking up, every lesson (T4-INT).

5.3.5 Student Grouping Strategies

Teachers in HP-schools had several grouping of students' practices as summarised in Table 5.12. In the HP-schools teachers organised students into after school study groups. These study groups met outside normal contact time to discuss and follow up work covered in the formal teaching sessions. They were convenient for cooperative learning and peer-tutoring. At HP2 the study groups were formed by students from different classes. Within the classrooms the teachers also formed small-groups for discussions. At the same time, T2 advocated for uniform coverage of the content in order to facilitate student study group discussions because, "These children need to interact very much during their free time...they need...the time to discuss with the colleagues in the other streams [classes]."

In contrast, the teachers in the LP-schools mainly helped those students who individually asked for help. At LP2 the students were divided into usually two groups for the purpose of drawing graphs. But, in LP1 the students were only grouped at the S.4 level. When T3 was asked whether he grouped his students he replied:

> Oh..., no, we, I don't break them into smaller groups. The reason is that now I am time-barred because of the syllabus coverage that I have told you about. I have to go back and then move ahead. I have not broken the students down into groups, but in senior four for example, I have groups (T3-INT).

Table 5.12 Students Grouping Practices by School-type.

HP-SCHOOLS	LP-SCHOOLS
-After school study groups -Cooperative learning and peer tutoring -Teacher facilitation -Mixed classes groups -In class small-groups	-Students' individual effort -Grouping in some topics

5.3.6 Assessment and Evaluation

Teachers in both HP- and LP-schools used several assessment and evaluation practices. The assessment was mainly diagnostic in both types of schools. But, the teaching within the schools in the study appeared examination driven in both types of schools. For example, T2 pointed out that:

> …the majority of the teachers drive the students towards passing the examination. But not knowing the mathematics, not relating the mathematics to the environment, yet if you are teaching mathematics students could recognise mathematics… So the way our syllabus is being treated is actually geared towards passing the examination. It is like coaching some concepts you say, please you must take them, it is like this, it is like this. The background questions are not there, how come? How is it? Why like that? Why not do like this. 'Why' part is not there in the teaching (T2-INT).

Similarly, at LP1, T3 pointed out that he gave more time to the external examination classes. According to him that was so, "because, now I am concentrating on with candidate classes, leaving these lower classes, otherwise I might have less time for the candidate classes, normally I give them, extra time, to beef up what they have," which he summed up as:

> But anyway, despite that, I have been trying to at least bring out people, at least you can have about ten with credits, at least some passes and of course failures … but we normally have that kind of thing (T3-INT).

Meanwhile, in the HP-schools, the teachers always conducted common tests and examinations. The teachers administered joint assessment for all classes at the same level. They gave students timed-written-papers for assessment. The teachers also jointly gave regular fortnightly and monthly review tests and daily homework exercises. The teachers in the HP-schools compiled their questions from different sources like the UNEB past-papers booklets, the textbooks questions, and the school's past-papers questions-bank. The teachers kept questions-banks of past-paper-questions from the UNEB and other cooperating and well performing schools. The assessment seemed more formative because the results were used to inform teaching. The teachers in the HP-schools also conducted review lessons. The lesson reviews were also intended to synthesise what the students had learned. They were meant to give them more engagement and to enable them identify gaps in their knowledge. The teachers argued that the lesson reviews helped the students to develop confidence in their ability to succeed in mathematics. The teachers provided students with outlines of the content to be covered which appeared to help them organise their ideas.

But, in the LP-schools the teachers used monthly tests and homework exercises to assess their students, as was the case at LP1 for example. The questions the teachers used were mainly derived from the school's past-papers bank and textbooks. However, the questions in the questions-banks that were seen were neither open-ended questions nor applications type problems but routine exercises. The teachers in the LP-schools also used lesson reviews. The teachers' assessment seemed more summative than formative. The lesson reviews questions contained some recently covered work and some work that had been covered earlier. T3 explained his practice as follows:

> What I normally do, I bring them, normally in senior three, if what they lost was in senior two, what I normally do, is to bring them questions and past papers from senior two, and by the end of senior two, I expect to have this, this and the other, so I normally begin from term one, when I see a term one paper, you come to term two, so that when they get a paper, I normally give them, say try the questions you think you can (T3-INT)..

Table 5.13 summarises the assessment practices that the teachers in the HP- and LP-schools used in their schools.

Table 5.13: Assessment and Evaluation Practices in HP- and LP- Schools.

HP-SCHOOLS	LP-SCHOOLS
-Joint timed-written-papers, end of unit, month or year tests and examinations -Fortnightly review tests -Homework -Questions banks and past question papers -Individual and group class work -Diagnostic and formative	-Individual teacher tests -Monthly tests and reviews -Textbook questions used as seatwork and homework -External examinations format -Examinations and exercises - Individual class work -Diagnostic and summative

5.3.7 Presentations of Lessons

The presentations of lessons had different patterns. One observation was that teachers in the HP-schools asked students probing questions and varied approaches as lessons progressed. For example, during his lessons, T2 provided worked examples in stages of stepped levels of difficulty from easy to hard to hardest as schematically illustrated in Figure 5.1. He (1) did the first problem on the blackboard; then (2) he together with the students did the second problem jointly on the blackboard; then (3) the students did the third problem together on the blackboard; and finally (4) the student then did the fourth problem individually in their exercise books.

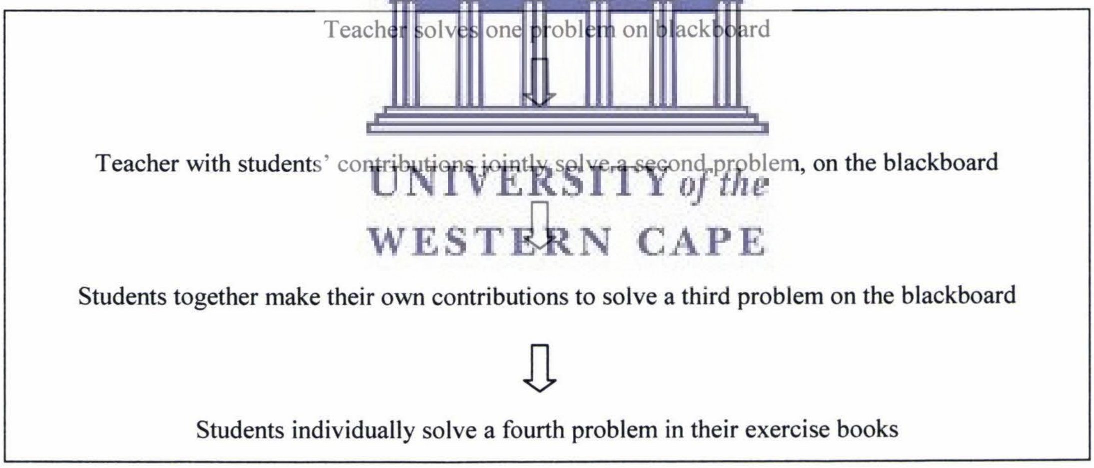

Figure 5.1: A scheme for solving worked examples.

Similarly, at HP1 as the students did the assigned problems T1 challenged them to state what they deduce from the information he had provided; elicited and provoked their understanding by asking the students what steps they would follow to extend a solution; and he encouraged them as they worked to work harder and faster. He accepted students' solutions but he tried to modify them. During the lessons, the teacher moved around the room to observe each student's work. The students were however usually busy and focused on the lessons.

Summary Lesson-Portrait of T1 and T2 in the HP-schools

In sum, the teachers in the HP-schools engaged in various activities during the lessons. The characteristic way of working is captured below giving some aspects of activities in the lessons' presentations that T1 and T2 gave. The teachers:

- Reviewed assigned problems while explaining solution procedures;
- Announced the lesson objectives to the students;
- Marked and corrected previously assigned problems but leave students to complete working individually;
- Introduced the new topic of the lesson;
- Provided worked examples with problems of stepped difficulty level from different sources such as textbooks and past paper;
- Moved around the class monitoring progress, supervising, correcting and marking students' work;
- Invited students to the blackboard to work out their solutions to problems;
- Challenged students to explain solution procedures as they listen, guide and facilitate;
- Asked provoking questions and answers;
- Recapitulated lessons with emphasis on what seemed not clear or not understood during the lesson;
- Assigned new problems as homework; and
- Gave reference sources for further reading on the topic.

Summary Lesson-Portrait of T3 and T4 in the LP-schools

In sum, the teachers' engaged in various activities during the lessons in the LP-schools. Their practices are captured by the following characteristic way of working from the presentations that T3 and T4 gave. The teachers:

- Cleared administrative chores such as roll call;
- Reviewed previous lesson's work and assignment;
- Took examples and do them on the blackboard and students copy;
- Introduced and explain new content in detail using worked examples;
- Called on students 'to think' and contribute ideas;
- Assigned students supervised seatwork exercises to do as they moved around the classroom marking and correcting;
- Corrected problems together with the students to the finish and students copy the solutions;
- Gave steps, procedures and rules to follow for solving problems;
- Solved one or two problems of assigned exercises on the blackboard;
- Assigned new homework exercises; and
- Told students what to do and how.

Overall, from the lesson characteristic way of working given above it is evident that the lessons differed. The teachers in the HP-schools announced the lesson objectives; they invited students to the blackboard to solve or explain their solutions; they challenged the students to explain their thinking; provided students with references for further reading on the same topic; and they generally followed constructivist and learners centred teaching principles. In contrast, the teachers in the LP-schools spent the initial minutes of lessons clearing administrative chores; they did examples on the blackboard for students to copy; they gave the students the steps, procedures and rules to follow in solving particular problems; they explained new content through worked examples; and they generally followed expository, teacher-centred teaching principles.

5.4 SUMMARY

This chapter described the qualitative findings of the study. The analysis was approached through a quasi-grounded theory approach. The two major constructs to which the categories were clustered: pursuing excellence and enhancing participation which were illustrated using the data. The data revealed that the teachers used various instructional materials that led to a variety of classroom environments. The different schools used different teacher deployment patterns such as the horizontal or vertical or ad hoc patterns to engage the teachers. At the same time, the teachers at the HP-schools used a synchronised teaching strategy and focussed on content coverage to facilitate the completion of the syllabus. Student difficulties were diagnosed through different techniques that included written and oral methods. The instructional approaches that were used attempted to take care of the student's individual differences. There were efforts in all the schools to provide the students with additional teaching sessions to improve on the students' performance and to make up for any shortfalls. Pursuing excellence promoted teachers' effort for the students to achieve better.

Teachers enhanced participation through their involvement in various activities and tasks. The teachers employed various assessment techniques to test students using mainly past-paper-questions kept in question banks. Teachers conferred with each other to try to improve their practices and performance in the classrooms. They also conducted different types of lessons, attended to and engaged students differently. The teachers perceived students as having different attitudes, primary school backgrounds, and varied freedom to communicate with others. The students were noted to have different primary backgrounds, attitudinal and admission characteristics that sometimes dictated on what the teachers could do in their classrooms and schools. Some of the teachers organised students into study groups to enhance peer-interaction. Enhancing participation promoted student attitudes towards mathematics and encouraged engagement in their work. The next chapter discusses the results, draws conclusions and makes recommendations of the study.

CHAPTER 6

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

6.1 DISCUSSION AND IMPLICATIONS

The primary purpose of this study was to investigate the relationship between student attitudes towards mathematics and achievement in mathematics problem solving. A secondary purpose was to investigate the nature of teacher practices in high-performing and low-performing secondary schools, based on the mathematics problem solving achievement scores in Uganda. More specifically, this study was designed to address six questions.

1. Are there relationships between student attitudes toward mathematics and achievement in mathematics problem solving?
2. Are there differences in student attitudes towards mathematics (a) by school-type and (b) by gender?
3. Are there differences in student achievement in mathematics problem solving (a) by school-type and by gender?
4. Are there interaction effects between school-type and gender on student attitudes towards mathematics and achievement in problem solving?
5. What do mathematics teachers do in their classrooms?
6. What do mathematics teachers say about their instructional practices and schools?

The student attitudes towards mathematics were surveyed and their achievement in mathematics problem solving tested. The participating teachers were observed teaching in their classrooms that included the surveyed students and they were also interviewed. For each of the six questions, a summary of the findings, discussion, and the recommendations that emerge from the findings, is presented in the following sections.

6.1.1 Are there relationships between student attitudes toward mathematics and achievement in mathematics problem solving?

To answer this question a Pearson r correlation was used. The results of this study confirmed earlier research studies related to the relationship between attitudes and achievement in mathematics. The results of this study suggest a weak positive relationship between student attitudes towards mathematics and achievement in mathematics problem solving among S3 students. The data shows that attitudes and achievement co-vary. This finding is consistent with evidence from other research that there is a relationship between attitudes and achievement (Ma, 1997; Ma & Kishor, 1997; Maqsud & Khalique, 1991a, b; Papanastasiou, 2000). For instance, Maqsud and Khalique found a moderate correlation between attitudes and achievement among secondary school students in the North West province of South Africa.

Mathematics anxiety has been found to have a negative relationship with mathematics performance and achievement (Hembree, 1990). Earlier researchers have reported a regular though small negative relationship between mathematics anxiety and performance with correlations ranging from -.11 to -.36 with students with high levels of mathematics anxiety tending to have lower levels of mathematics performance (McLean, 1997; Tocci, & Engelhard, 1991). Although several researchers have viewed mathematics anxiety as a subject specific symptom of test-anxiety, this study did not investigate that link.

6.1.2(a) Are there differences in student attitudes toward mathematics by school-type?

A critical component of this study was to investigate student attitudes towards mathematics and their achievement in mathematics problem solving. The student data from the SATMI were used to answer this question. The findings of the current study revealed a statistically significant difference in mathematics anxiety between students in the HP-schools and students in the LP-schools. Students in high-performing schools are less anxiety prone while those in the LP-schools appeared more anxiety prone. For example, the students in the HP-schools were significantly more confident in learning mathematics than those in the LP-schools. The difference in confidence to learn mathematics could have originated from other sources such as the home background, parental and peer encouragement.

According to available data most of the students in the HP-schools had quite highly educated parents whom they could consult about their work, even at home. This was not the case with the students from the LP-schools most of whom had less educated parents, some of whom did not even attend school. The strong primary background from which the students in the HP-schools came could have contributed to their being more confident in their mathematics. Perhaps because the general public seems to trust that the students in the HP-schools will do well, and usually they do, the students satisfy that prophecy. From personal experience, the general public believes that some of the HP-schools are the "homes of tomorrow's leaders." Indeed there are role models in society to confirm that. The teachers in the HP-schools challenge the students to excel and build confidence both in and outside the classroom. Such opportunities do not seem to be offered to the students in the LP-schools. The importance of making students confident in their ability in mathematics has been stressed by the National Council of Teachers of Mathematics (NCTM, 1991, 2000). The confidence of students in the HP-schools was also evidenced when teachers called them to the blackboard to give oral presentation of their solutions, ideas or to defend their work. When teachers called students to the blackboard to justify their work it seemed to enhance student participation in the class activities and they showed a degree of positive attitude to the work they were doing.

The results of this study indicated differences in levels of mathematics anxiety, the confidence to learn mathematics and motivation in mathematics among students in the different types of schools. These attitudes could be attributed to the school's culture and the way the teachers play their teaching roles. It appeared that the school location did not determine the nature of student attitudes in this sample of schools. In the schools' sample, 77.8% of the schools were rural schools, although the other 22.2% of the schools were urban schools that could be termed 'urban schools with rural parents'.

The implication this result for teachers is that since not all students are intrinsically motivated in the classroom they need to translate the curriculum in terms of skills that students would find relevant and interesting (Boekaerts, 2002). Students could become more involved if what they are taught and what they learnt were applied to real life situations. At the same time teachers could assist the students to become more motivated learners through their exemplary behaviour and the assertions that they make in the classrooms. To build task involvement and motivation in mathematics classrooms Kloosterman and Gorman (1990) have suggested that teachers need to communicate to students that they know they can learn mathematics; praise student effort and performance when deserved; employ cooperative grouping and encourage discussion of mathematics among students; when students go wrong in a problem, encourage them to try again and again rather than letting them to worry about their failure.

Secondary school teachers need to know the primary academic background of the students they teach. Students' academic history should be shared between the primary, secondary and tertiary education levels. There should be a stronger link between the primary schools and the secondary schools than is currently the case. In this way teachers would know the student attitudes and possibly help them to develop more positive attitudes and to guide them on how best to teach them. The success of a school needs to be a combined effort of the society, parents, and teachers.

6.1.2(b) Are there differences in student attitudes toward mathematics by gender?

To answer the above question the data collected from the SATMI questionnaire were used. The results of this study indicated that there was a significant gender difference in mathematics anxiety among the students studied, with the females being more mathematically anxious than the males. There was no evidence to suggest a gender difference in Motivation to learn mathematics among the S3 students studied. But, less than 83% and 98% of the students in the HP- and LP-schools respectively scored 50% on the motivation scale. In general this result is consistent with the findings of Meece (2003) that lack of motivation in mathematics continues to be a problem in many countries of the world. However, females in the HP-schools obtained significantly higher mean scores in MOTV than females in the LP-schools. The females in the HP-schools were perhaps partly motivated by the good passes they received at the PLE after the primary school level. And perhaps because the HP-schools usually have long history of doing well, these schools have a traditional school culture of excellence. The students, both males and females, in these schools seem to have responded accordingly to maintain standards. So the females could be motivated to maintain the status quo as one of the study girls-only school was one of the best performing schools in the country. In addition, the collaborative practice that the teachers used through discussion groups such as discussion of teaching approaches, peer collaboration, the use of common schemes of work, and joint testing seems to promote a model for students' motivation to learn do well together as a group.

Furthermore, a significant gender difference in confidence to learn mathematics was found among the S3 students studied. The males showed higher confidence than the girls. This result confirms and supports earlier research studies that have shown consistent gender differences in mathematics confidence, with males being significantly more confident than females (Hyde, et al., 1990). The data in this study support the assertion that even when women are successful at school they often express lower confidence in their ability to meet new mathematical challenges (Drzewiecki, & Westberg, 1997; Meyer, & Koehler, 1990). The differences could also accrue from other individual based differences or through external conditions. There will be differences between students who have learning difficulties and those who are gifted and able to do mathematics.

The implications of these results for teachers are that they need to be aware of gender differences between students because teachers could contribute to females' negative attitudes towards mathematics by using gender-biased practices like giving females less attention during class. There is research evidence that girls have positive attitudes towards school but negative attitudes towards mathematics. The teachers also need to be aware of the evidence that girls' positive attitudes towards mathematics decline as they grow older. From personal experience it seems girls would enjoy mathematics if mathematics were taught in a cooperative setting that takes advantage of the strong tendency of females to be more social than males. Girls appear more cooperative than competitive learners in mathematics.

Teachers must try to reduce mathematics anxiety among students by using different teaching methods such as cooperative learning. From the observation of lessons the males tended to dominate class-talk in whole class instruction. The female students appeared less willing to participate in class activities than the males in mixed schools. The participation of students was not a problem in single sex schools. But teachers need to be aware there could be variations in gender differences in mathematics across schools and across teachers. Teachers need to engage girls to answer questions and to give them praise when appropriate and deserved. Even when students are taught in single sex schools, some of them will still have negative attitudes towards mathematics. This finding was evident about girls in girls' only schools who still showed negative attitudes towards mathematics. And there is evidence that separating girls and boys during mathematics instruction does not improve the girls' negative attitudes towards mathematics.

6.1.3(a) Are there differences in student achievement in mathematics problem solving by school-type?

The student data from the MPST were used to answer this question. The results of the problem solving assessment showed that students in the HP-schools performed better in problem solving than their counterparts in the LP-schools. This result confirms the differences in grades awarded to the students at the time they sat PLE. The HP-schools admitted mostly the best students in the country who seem motivated to attack unfamiliar problems. Students in HP-schools appeared to have more opportunities to learn than the students in the LP-schools. From the teacher interviews, it was evident that students in the different schools covered different amounts of syllabus content. The time that was lost in the schools, like poor turn-up at the start of term, as T4 reported at LP2 was often difficult to recover. This finding is consistent with the finding that "the amount of time that teachers spend on mathematics is another indicator of students' opportunities to learn mathematics" (Hawkins, Stancavage & Dossey, 1998:56). According to the teachers in the HP-schools, they provided regular feedback to their students to try to improve on their performance.

A scrutiny of the students' solutions revealed that the students in the HP-schools wrote superior quality of solutions to the MPST than the quality of the responses of the students from the LP-schools. Moreover about 30% of the students in the LP-schools returned blank answer sheets to the MPST. Another possible explanation for differences in student performance in HP- and LP-schools is that teachers in HP-schools provided some open-ended and investigative type tasks to their students as their practice as was reported in HP2. Teachers need to be open to student solution methods and interaction with students. In other words teachers must encourage students to find their own solutions strategies and provide students the opportunity to share and compare their solutions methods and solutions (Grouws & Cebulla, 2000).

Another possible explanation for the variation in performance is that HP-schools admitted the best students from the primary education level. These students were often regarded as 'the academic cream' in the country. The types of problems in MPST were not the usual textbook type questions that students were used to. Students in HP-schools appeared to have been prepared or were able to confront new unfamiliar problems from a variety of sources and supplemented by the way parents were involved in the student learning which Walberg and Paik (2000) also pointed out. This finding is consistent with the result that "variations in academic performance among schools are connected closely to the family situations that prevail in the schools" (Caldas & Baukston, 1999:97). These, among other reasons seem part of why students in the HP-schools performed better.

The implications of these findings are that teachers need to have high expectations of students they teach and teachers should guide students to set goals and aims and help students to achieve them. Because the teachers were aware of differences in mathematics achievement between the students in the HP- and LP-schools at the time of admission the teachers should ensure that students are given the time and opportunities to learn important curriculum content to try to bridge any differences. Teachers must maximise the limited classroom time available to engage students in lesson activities. There is evidence that the opportunity to learn mathematics content bears directly and positively on mathematics achievement (Grouws & Cebulla, 2000).

Teachers need to use cooperative learning strategies to avail students the chance to work together in pairs or in small groups on follow-up practice problems. At the same time teachers should use a variety of formal and informal assessment techniques that are aimed at diagnosing and monitoring student progress and learning and for improvement of the curriculum. There is evidence that when students work in small, self instructing groups they can support and increase each others' learning (Walberg & Paik, 2000) because "using small groups of students to work on activities, problems and assignments can increase student mathematics achievement" (Grouws & Cebulla, 2000:21). Teachers must therefore encourage students to work collaboratively and help one another. Teachers must promote students working out their own solutions to problems and get chances to share and compare their solution approaches with those of other students during and after the lessons.

6.1.3(b) Are there differences in student achievement in mathematics problem solving by gender?

The student data from the MPST were used to answer this question. The results of the present study indicated that there was no evidence to suggest a significant difference in achievement in mathematics problem solving between male and female students. The males' scores were however higher than those of the females, but this difference was not significant. This study supports the findings of minor but non-significant gender differences in mathematics achievement among S.3 students in Uganda by Opyene-Eluk and Opolot-Okurut (1995). However, it is important to note that Opyene-Eluk and Opolot-Okurut had defined school-type as single sex and mixed sex schools. The current study categorised school-type as HP- and LP-schools as defined earlier.

Some previous studies have shown gender differences in performance in mathematics in favour of males (Campbell & Beaudry, 1998; Hedges & Nowell, 1995). For example, Campbell and Beaudry's (1998) study that used public school students who participated in the Longitudinal Study of American Youth (LSAY) found a 10.8% gender gap in favour of males with high-achieving males scoring higher in the 11^{th} grade mathematics compared to the high-achieving females. This gender differences are however getting smaller in some countries like UAE (Alkhateeb, 2001), the United States (Hyde, Fennema, & Lamon, 1990). However, the latest results released in March 2004 indicate that females are achieving consistently better than the males in the United States (Perkins, et al., 2004).

6.1.4 Are there interaction effects between school-type and gender on student attitudes towards mathematics and achievement in problem solving?

The results indicated that there were significant main effects on mathematics anxiety and confidence in mathematics by school-type and gender but the interactions were not significant. The results imply that student levels of anxiety and confidence do not depend on the combination of school-type and student gender. Hence, it does not matter whether a student is from an HP- or LP-school, a male or a female.

Furthermore the results indicate that there were significant main effects on motivation to mathematics and mathematics problem solving by school-type and not by gender and the interactions were not significant either. There was no evidence of a difference on motivation and achievement in mathematics by gender. The results indicate that student levels of motivation and mathematics problem solving do not depend on the combination of school-type and student gender. Therefore, it does not matter whether a student is from an HP- or LP-school. But the motivation seems to depend on the gender.

6.1.5 What do mathematics teachers do in their classrooms?

To investigate the nature of teacher practices in the HP- and LP-schools two questions were examined: What do mathematics teachers do in their classrooms? And what do mathematics teachers say they do in their classrooms and schools? The study yielded information related to the first question from classroom observations. The description of the teacher practices in this study was intended to serve as an illustration of the particular teaching practices that teachers used. The findings explain how the teachers struggled to ensure that students achieve better. And through enhancing participation the teachers tried to develop in students positive attitudes towards mathematics. Viewed from that perspective, the results indicate relationships among teacher practices, student attitudes towards mathematics and achievement in mathematics problem solving. This study showed that there was limited use of technology in the classrooms visited. Even though calculators were available in small quantities in each classroom, they were not extensively used. These findings are consistent with the results of other surveys in several respects. Previous studies such as by Huang & Waxman (1996) have shown that technology was not widely used in schools and classrooms even in a developed country like the United States. The findings in this study support those results. Some possible explanations for the limited use of calculators are that technology such as calculators are still expensive in Uganda for the average student. Schools do not supply calculators to students and schools are not spending much money on acquiring such technology for teaching. Yet, inevitably with the advance in technology, teachers may need to increase the use of technological resources such as calculators in teaching mathematics.

In the development of the lessons the findings of this study indicate that the teachers from the HP-schools engaged students in more practical mathematics using various teaching aids than the teachers in the LP-schools. There was also an emphasis of daily life applications of the topics that were taught. On the contrary, the teachers in the LP-schools were more interested in getting the syllabus completed. In the course of teaching, whereas the teachers in the HP-schools used a scheme for doing worked examples, they left the students to complete the working. But, the teachers in the LP-schools would do all the work on the blackboard for the students to copy following a predetermined pattern that they always used. Even without having been directly exposed to the vision of the NCTM, it would appear that some of the teaching in the HP-schools is consistent with the teaching principle advanced by the NCTM (2000) that "mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (NCTM, 2000:16), as the teachers challenged and tried to support their students. Certainly the quality of mathematics teaching and learning seems to depend on what teachers do with their students, and what teachers can do depends on their knowledge of mathematics and their mathematical knowledge for teaching.

The use of worked examples supports Renkl's (2002:529) finding that "learning from worked-examples is very effective for initial skill acquisition, at least when the learners actively explaining the solution steps in the mathematics to themselves when learners engage in." But sometimes the danger with worked examples is that they could be closed and identical in form to the pattern of the questions in assignments that students are given. Such a danger has been observed in the examples in textbooks in England in a study by Haggarty and Pepin (2002).

There appears to be a need to plan for more time for teaching mathematics than currently timetabled. At the moment although HP-schools spend 3.3 hours of school time per week on mathematics, the LP-schools spend four hours a week on mathematics. However, the students in the high-performing schools seem to get more opportunities to learn through the additional teaching sessions that the teachers arrange. The UNCST (1999) recommendation of 12 periods per week, which was not implemented, may have to be revisited. Certainly the students were given time and opportunity to learn mathematics, which is one requirement for students to acquire high-quality mathematics education (NCTM, 2000) but probably not enough. The amount of time available could adversely affect both the implemented and the achieved curricula that are related as shown in the SYTEST model that was earlier shown in section 1.2. It is interesting to note that additional teaching sessions were conducted in both the HP-schools and the LP-schools. Two options come to mind about what schools face: whether they need more time or whether the current allocation of time they have could be more productively used. But, probably the latter option may be more feasible and productive.

These findings extend previous research findings on the instructional approaches reported by Ottevanger, Leliveld and Clegg (2003) by illustrating that teachers engage in more practices than those practices reported for Uganda. This signals the strategies teachers use to overcome the "overloaded curriculum" and the "pressure to complete the syllabus [that] prevents teachers to use more cooperative strategies in teaching" in Uganda and other countries in sub-Saharan Africa (Ottevanger et al., 2003:3). But in addition such pressures the diversity of students (Lou, et al., (1996) could also restrict teacher practices. But how each teacher in each school covers the syllabus content remains a matter of personal ability and industriousness.

At the end of the lessons the teachers in the HP-schools made oral summaries and highlighted the main points of the lesson. In the LP-schools the lessons sometimes ended up abruptly. Above all the teachers appeared to conform to the aims that are stipulated in the curriculum documents and textbooks in the country. The teachers have little access to other documents such as the *Standards* proposed by the NCTM (2000) to be informed of the changed roles of the teachers and learners but heavily rely on the ideas they gain from training institutions. It would appear that the way teachers interact with students might inhibit or propagate differences among students.

The implications of these findings are that teachers need to pay attention to how they conduct their lesson. They need to start each mathematics lesson with a reminder to students about the work that was done during the previous lessons and conclude the lessons with a summary of what was taught in the lesson to guide students' learning. At the same time, the teachers should be willing to listen to student ideas and opinion about the work that they are doing and to use students' ideas to develop further discussion.

6.1.6 What do mathematics teachers say about their instructional practices and schools?

The study yielded a great deal of information with bearing on this question from interviews with classroom teachers who provided a wealth of data on what was happening in their schools and classrooms. In the analysis of the qualitative data from the interviews, the lesson observations and the audio taped transcripts the following results were found. First, the teachers in LP-schools mainly conducted more whole-class, teacher-centred expository teaching and organised their classrooms in traditional rows and columns than the teachers in the HP-schools. The pattern of teaching in the LP-schools showed that the teachers were in control of what was taught, when and under what conditions the teaching took place in the classroom. This finding replicates the observable measures of teacher-centeredness instruction advanced by Cuban (2001). The teachers in both types of schools probably teach in the same traditional way they were taught. This finding is at variance with the emphasis for teachers to adapt learner-centred teaching (Evans, 2002; McCombs, 2003a, b; Meece, 2003). Learner-centred teaching is envisaged to improve student academic engagement and learning, promote intrinsic motivation to learn and that recognises learner individual differences. However, the teachers in the HP-schools were observed to be more flexible in their practices, using the available instructional resources and materials at their disposal than the teachers in the LP-schools. This finding is consistent with the adaptive education using a variety of instructional techniques that Walberg and Paik (2000) noted could raise student achievement if applied to lessons for individual students and small groups. Though teachers in the LP-schools seemed more constrained by the shortage or lack of resources and materials, the difference in the use and quantity of instructional resources and materials in the two types of schools support this view. The data indicated that there were more instructional resources and materials in the HP-schools than in the LP-schools.

Second, the interviews with the teachers revealed that students in HP-schools were streamed according to ability and performance whereas the students in the LP schools were kept in mixed ability classrooms. When questioned about the difficulties that the mathematics teachers experienced, the common response was that the heavy workload involved teaching many lessons in different classes and marking. There was a shortage of mathematics teachers in all types of schools although the HP-schools were slightly better staffed than the LP-schools. From the interview data some of the teachers revealed that sometimes some of the teachers in the HP-schools also taught in some of the LP-schools. Because of the shortage of mathematics teachers the few available teachers who were posted to a particular school could unofficially, if they so wished, arrange to be teaching in other schools as well for extra pay. The teachers described the practice as "Mungo Parking or moon-lighting" usually conducted to try to "make ends meet." The student-teacher ratio varied with a higher ratio in the HP-schools (1:45) than in the LP-schools (1:33) derived from Table 5.2. This ratio did not seem to affect the way the students were taught although Bennett (1996) has rightly cautioned that class size may affect the teacher's planning and preparation, matching and differentiation, class organization and assessment and diagnosis.

Third, the teachers advanced various reasons to support conducting of additional teaching sessions as presented in Table 5.6. Three of the reasons are:

1. To re-teach already covered work that clarifies what was not understood and not clear;
2. To attend to student individual differences so as to bring them up; and
3. To review the work covered in earlier lessons, terms or years and to catch up.

It appears that every available free time in the school day was used. As indicated in Table 5.6 the time for the additional teaching sessions varied in the HP-and LP-schools. In the HP-schools the additional teaching sessions were conducted during preparatory time and during the breaks whereas in the LP-schools the additional sessions were conducted during the holidays and at the early morning before the official beginning of school. The preparatory time was convenient for the HP-schools because they were boarding schools and during holidays was convenient for the LP-schools because the students were usually from the local community around the school. It would appear that the late payment of school fees, truancy and tardiness on the part of the students partly accounted for the late start of LP-schools. In the HP-schools the additional teaching sessions are accepted school routine that were supported and encouraged by the school administration. The teachers were financially remunerated for additional teaching. But in the LP-schools the additional teaching sessions though appearing to be accepted by the school administrations were not supported by additional remuneration. In the HP-schools the main goal of the additional teaching was the maintenance of content coverage, whereas in the LP-schools they were for catching up with uncompleted content. That meant that either there was too much syllabus content to complete or the time allocated to mathematics per week was not enough.

Furthermore, this study also found the following features of the nature of teacher practices. First, teachers in the LP-schools did most of the teaching from a single textbook as a content source but the teachers in the HP-schools used several sources. This finding replicates Kiragu's findings in Kenya. Kiragu (1995) observed that the teaching of standard six mathematics classroom was predominantly characterised by: (1) the use of several examples from the textbook; (2) a lot of emphasis was put on following routines established during the lesson to solve the assigned problems; and (3) students were not given opportunity to do problems outside the textbook or even to discuss the solutions among themselves, or to explore various ways of arriving at a particular solution. This pattern of characteristics was more-or-less replicated by Wong (cited in Clarke, Clarke & Sullivan, and 1996:1211) who claimed that most mathematics teachers then taught in accordance with three things namely: (1) the text book, (2) the examination syllabus, and (3) the past papers in public examinations.

Second, the findings show that there is a shortage of teaching and learning materials mainly in the LP-schools. However, the teachers in the HP-schools had access to and used more instructional resources and materials and a greater variety of textbooks than their counterparts in the LP-schools. This finding is consistent with the findings of the research on the trends and challenges in instructional practices in different countries in the Sub-Saharan region. It is well documented that "many of the country profiles emphasise the lack of adequate teaching and learning facilities, textbooks and pedagogical materials" coupled with their availability, supply and evaluation and selection (Ottevanger, et al., 2003:3). The findings in this study echo the position of instructional materials in other Sub-Saharan countries that were studied. For example, in South Africa it was reported that "because of the lack of resources in many schools, the teacher is often the learners' only resource to learning" (Ottevanger, et al., 2003:3). The differences in the quantity of instructional materials are also attributed to the financial position of the school and the interest of the administration. This finding though is inconsistent with the experience of the

American teachers who reported getting the materials they needed for teaching their classes (Hawkins, Stancavage, & Dossey, 1998). The economy of the country certainly plays a role on what teachers can be availed to facilitate their teaching.

Third, another finding was that student interactions promoted by study-group discussions was used in the HP-schools but not in the LP-schools which gave the students in HP-schools more opportunity to interact among themselves. This supports the finding that students' interaction is facilitated through cooperative learning settings (Leikin & Zaslavsky, 1997; Slavin, 1991; Walberg & Paik, 2000), grouping for instruction in mathematics (Good, Mulyan & McCaslin, 1992) and that the interaction observed among students was correlated with the assistance they get from and give to each other (Nkhoma, 2002; Webb, 1991). Though peer grouping has predominantly been conducted in the classroom through pairing or small groups of students (Evans, Flower & Holton, 2001), no specific student characteristics such as grouping by ability or gender within the classroom were observed in this study.

Fourth, another finding of this study was that the teachers applied their perceptions of students to guide their teaching. The teachers took into account what they considered their students' attitudes, their grades at the time of admission, the students' primary background, and the students' freedom to communicate, as was outlined in Table 5.11. This finding is consistent with the finding of Thompson (1992) that teacher practices are shaped by their beliefs and conceptions. This means that the teachers tried to adjust their teaching according to what they saw as students' needs and abilities, in a manner in which they perceived it. For example, the teachers in the LP-schools believed that some of their students had negative attitudes towards mathematics that they attributed to poor primary academic background. For instance, as a result T3 sometimes simplified the work and problems for the students. When he worked on a problem involving plotting graphs of functions he assumed that that problem was a bit hard for students whom he claimed are slow to know that two tables were to be drawn for one question. He then removed the equation $y = x + 1$ in the first instance and put an alternative one that was meant to be an easier problem that was almost obvious for the students to see and do.

Fifth, this study found that teachers in one HP-school were mainly deployed in the vertical deployment pattern, but the teachers in one LP-school were deployed in the horizontal deployment pattern. In the vertical teacher deployment pattern teachers progress upwards with their group of students each year to the next class, as T2 explained what they do in their school that they progressively move with the same group of students each year. But in the horizontal teacher deployment pattern teachers teach at a particular level and receive new students in that class each year, as T3 explained he was assigned to be teaching the same, especially candidate classes each year since he joined the school. The differences in the teacher deployment patterns may originate from the number of mathematics teachers in the school. There was therefore differential management of teaching in the different schools.

Sixth, another finding of this study was that the teachers in the HP-schools reordered the syllabus and textbooks topics for the logical convenience of teaching. They then taught synchronized lessons so that all the teachers taught the same content at the same time. Meanwhile the teachers in the LP-schools taught topics following the textbook layout. The topics in the textbooks that are used in the country follow a spiral approach to the topics such that the topics recur year after year. But in the reordered arrangement the content of the related work were collapsed together and taught over a shorter period. This was to avoid having to loose track of the content and later having to re-teach it to refresh students' memories when they are picked up again. Furthermore, all the teachers in the HP-schools structured their teaching according to the way topics appeared in the final examination papers.

Seventh, the study found that there was more collaboration between the teachers in the HP-schools than in the teachers in the LP-schools. There was more academic focused discussion among the teachers at different times. The teachers discussed teaching approaches, the work assigned to students and the general planning and scheming of the content to be taught. In contrast, the teachers in the LP-schools often worked in isolation to make their schemes of work and preparation to teach. The school environment in the HP-schools appeared conducive to collaborative work. There was facilitation by the school administration and the colleagues were willing to work together. But, perhaps because of the small numbers of teachers the teachers in the LP-schools struggled on their own most of the time.

Eighth, this study found that teachers in the HP-schools made lesson plans as they prepared to teach but the teachers in the LP-schools usually had no lesson plans of the lessons they taught. It would appear that in addition to other uncontrolled variables teaching experience played part in the teacher's decision to write lesson plans. Both teachers in the LP-schools had over 15 years teaching experience and did not see the need for lesson planning. The teachers in the HP-schools had 6 years teaching experience yet they didn't show that the lesson plans had "lost capacity."

The lessons started with motivating introductions in the HP-schools to link the current lesson with the previous work. But, in the LP-schools the introduction of the lesson were devoted to role-call and other administrative chores, which consumed some of the time. However, lesson plans and lesson planning were central elements of the teacher's work because they identify the possible structure and content of the lesson to be taught. It became clear that the proposed TLAILO instrument for assessing teachers was not in use in the schools visited. As discussed in section 1.2 on the research setting the instrument was intended to evaluate teacher's preparation and planning, lesson presentation and student participation and involvement among other things.

Ninth, another finding of this study was that the teachers in HP-schools availed their students more opportunity to talk in the classroom with a resulting higher level of student engagement than the teachers in the LP-schools. The data from the Flanders' interaction analysis reported in Table 5.10 indicates more student initiated talking in the HP-schools (19.3) than in the LP-schools (5.9). Thus, active class participation does not necessarily require the students to give the 'right' answers, but the willingness to learn through sharing of information, views and thoughts with others. The teachers in the LP-schools appeared to conduct lessons that were consistent with teacher-centred instruction, where they controlled what was taught, when it was taught and the conditions of teaching within the classroom (Cuban, 2001).

It seems that as a result of the encouragement some of the students gained confidence in the classrooms and were freer with the teacher. They expressed themselves freely since they could even express their opinions to the teacher without fear. In general, the students talked quite openly in the class. The researcher personally observed that one student who was doing a problem at the blackboard looked like she was enjoying herself, as she was able to respond confidently to other students' questions and take criticism with courage. The teacher predominantly used the scheme outlined in Figure 5.1 involving doing worked examples of stepped difficulty. The teacher then gradually allowed students to take over the responsibility of working their own solutions. However, the students were not quite challenged to attempt to explain why the errors occurred or to say what may have gone wrong and to offer possible explanations. Noteworthy is the fact that as students responded to the teacher, the students in school HP1 had the discipline to stand up as they speak to the teacher, this was the only school this student behaviour was observed.

Tenth, another finding of this study was that teachers in the HP-schools organised their students into study groups outside the classroom. It was however only in one HP-school (HP2) that after school grouping practice was observed. This finding is consistent with the practice in the United States reported by Lauer, et al., (2003) on out-of-school-time strategies used to try to help the low achieving students in Reading and Mathematics. One obvious explanation of the findings is that expository teaching, where students are seated facing the teacher who acts as the transmitter of knowledge was dominated. However, the teachers at HP-schools were sometimes able to alter the seating arrangement of the classroom as they saw it fit for group discussion.

But in the LP-schools, T3 argued that students were not divided into groups because according to him, "he was time barred in syllabus coverage." The pressure on the teachers to teach students to pass examinations is huge and so they had to struggle to at least complete the syllabus even at the expense of student understanding of the content.

Eleventh, another finding of this study was that teachers in the HP-schools conducted joint examinations fortnightly to assess and evaluate their students, but in the LP-schools individual teachers prepared their own assessment questions as outlined in Table 5.13. In addition, teachers conducted additional teaching sessions in all study schools. These findings replicate the findings of Nkhoma (2002) who found that students in South African secondary schools attributed their success in mathematics to extra classes they were taught. The extra classes taught in South African schools are similar to additional teaching sessions that teachers in Uganda were using. Lauer et al. (2003) found that out-of-school (OST) strategies such as summer schools, after school sessions, extended day, before school sessions, vacation sessions and Saturday schools were effective in assisting low-achieving students in Reading and Mathematics in the United States. Though these sessions provided more time for remediation and for tutoring for low-achieving students they could as well be used for other students as they were being used in Uganda.

Finally, teacher interviews and classroom observations indicated that textbooks are a primary determinant of what is taught in both HP- and LP-schools, though textbooks were fewer in quantity in the LP-schools. But in sum, the study did not identify specific, dominant classroom instructional practices, or instructional materials that might explain higher attitudes towards mathematics and mathematics achievement in the HP-schools. However, the differences in student backgrounds and teachers practices in the different types of schools could possibly partially account for the variation.

6.2 CONCLUSIONS

The analysis of data gathered in this study provided insight into the student attitudes towards mathematics and their achievement in mathematics problem solving. They also provided portraits of teacher practices in HP- and LP-schools. The results of this research study enable us to draw several conclusions and reflect on directions for future research.

The findings of this study indicate that there are differences in student attitudes towards mathematics. In particular, students in HP-schools have lower anxiety, higher confidence and motivation than their counterparts in the LP-schools as measured by the SATMI questionnaire. Similarly, the findings indicate that male students showed lower anxiety and higher confidence than the female students. The single scale that did not show a significant difference was the Motivation scale. It is significant that this study found no difference in levels of motivation between male and female students.

Further analysis indicates that students in the HP-schools achieve significantly higher in mathematics problem solving than the students in the LP-schools. And, there was no significant difference in achievement of the male and female students in the MPST. A comparison of student attitudes towards mathematics and achievement in mathematics problem solving revealed low, but significant positive correlations, that ranged from .148 to .185 between the two variables.

The teachers appear to practice combining the school, the classroom and the social context interaction of the teachers and the students for the benefit of the student outcomes according to the conceptualised framework of the study outlined in section 2.9. The school, the teachers and students and student outcomes seem related.

6.3 LIMITATIONS

There are several limitations of this study that warrant interpreting the results with caution. First, only four teachers were deeply investigated. It would be useful to examine the practices of a larger sample of teachers. In addition, the teachers were drawn from only schools designated, as HP- and LP-schools yet there are more teachers in the medium performing schools whose practices ought to be investigated as well.

Second, the schools were selected for the study on the basis of results over a two-year period 1998 and 1999 only, and on their basis of easy access and convenience to the researcher. The schools and students who participated form only a small portion of the 2,055 secondary schools in the country, and about a quarter of the secondary student population of the 175,492 (25.7%) in the region, from 683,609 secondary students in the country (MoES, 2004). Because the participating schools were not a random sample of all the secondary schools, the results of the study may not be representative of all the country's students and teachers.

Third, the study was restricted to only the third term months of the school year over a three-month period (September–November 2001, and October-December 2002) because of other reasons like the availability of the researcher. The third term happens to be shorter than other terms because it is interrupted by end of year promotional examinations.

Fourth, the teachers were observed teaching on two occasions only. It was not possible to make more visits and spend longer time at study sites and so it was impractical to observe teachers teach more times. Perhaps more lesson observations and interviews would have revealed teacher practices that would have shown greater impact on students' attitudes toward mathematics and achievement in mathematics aptitude problems. Furthermore we would have collected richer data with more observations. In terms of the qualitative measures, our classroom observations and interview results may have presented the "best portrait" of the teachers, as these teachers could have changed their behaviour in light of being observed, interviewed and audio-recorded. To minimise this effect, prior rapport was made with the teachers and the classrooms were visited before the actual data collection was started.

Fifth, the instruments that were used had a few shortcomings. The SATMI required a self-report data from the respondents and it was not possible to verify the responses as genuine. This could have compromised the reliability and validity of the instruments. In fact the AXTY and the CONF scales were highly correlated and the MOTV scale had a low internal consistency coefficient that could have affected the results. It could be argued that all these scales measured the same attitude. If the

SATMI were to be reconstructed then other different scales should be included to measure a wider range of attitudes towards mathematics such as the Usefulness scale, the Teachers scale, and the Attitude towards success in mathematics scale in the Fennema-Sherman Mathematics Attitudes Scales (1976a, b).

Sixth, the problems in the MPST were of unfamiliar format to many students. The students were not used to this type of problems and could have affected their approach to solutions. The fact that some of the students scored zero may not have reflected that they did not know anything. Either the problems were too difficult for the students or they were not interested in participating in the study. It has to be borne in mind that the students were selected by random sampling in a school, but individual students were not asked for permission to participate. Permission to use students in a school was granted by the head teacher. The choice of the problems for the MPST used the same kind of problems on factors of numbers and did not cover a wide spectrum of the syllabus areas. Therefore, if a student had difficulty with this content area they would have received a low score. If the test was to be reconstructed it should have problems to test a wider range of mathematical content.

Seventh, the coding exercise to the FIAS sheet from the audiotapes was an innovative approach open to errors. The interviews held with the teachers could have been limited by possible reporting bias. It is possible that the teachers could have given responses to the interviews in a way they felt the researcher was interested to know. If that was the case then it could have introduced some bias in the responses. Some of the teachers were freer to talk their minds than others.

Eighth, this study was conducted as a snapshot of the students' and achievement. As such they cannot capture the true nature of the development of the attitudes. A growth trajectory over time using multiple-point measures of the attitudes and achievement would be more appropriate, but also more difficult to accomplish. The researcher is aware that in studying only single-point measures of affect or achievement studies do not document actual nature of learning but simply report instantaneous occurrence or status of those measures (Mazar, (1998). Yet learning entails growth and change over time. Affect and achievement are suitable to capture growth and changing experiences using multiple-point measures.

Finally, the findings of the study may not be generalised to other secondary schools in other regions because of the small numbers, as would be the case with naturalistic studies. However, the results could be generalised to socio-cultural theory.

6.4 RECOMMENDATIONS

The recommendations are considered in two parts (1) for the schools, educators, mathematics teachers, and (2) for further research.

6.4.1 For Schools, Educators, and Mathematics Teachers

The quantitative and qualitative data in this study and the discussion that has been presented and aware that no study ever answers all questions and that sometimes studies create more questions than they answer. Some resulting recommendations from the findings include:

1. Schools should adapt a policy of providing teachers with opportunity for professional development in and outside the schools so that they update their content and pedagogical knowledge so as to keep abreast with the current debates in mathematics education;
2. Teachers should be availed opportunities to interact and to collaborate with teachers within a school and between schools, especially between teachers in HP- and LP-schools to share their experiences, resources and expertise, particularly to share exemplary practices through teacher-networks, workshops, and seminars;
3. Teachers need to pay more attention to the use of calculators in the learning of mathematics as there is research evidence that the use of calculators can result in improved student attitudes and increased achievement. At the same time teachers should provide a supportive classroom environment as students tend to learn better within cohesive and caring learning communities (Grouws & Cebulla, 2000).
4. Teachers should work towards setting clear goals and intellectual challenges for student learning; they should employ appropriate teaching methods and strategies that actively involve learners; and they should communicate and effectively interact with students to improve their attitudes and achievement.

6.4.2 For Further Research

Some appealing and potentially productive areas for future research suggested by this study include:

1. An investigation of teacher practices at different school levels (primary and tertiary) or in different classes at the same level. Because this study only looked at teachers of S3 classes a replication or an extension of this study to other levels is necessary to help understand the state of mathematics education in Ugandan schools.
2. A re-examination of student attitudes with an improved SATMI questionnaire including other attitudinal scales, to capture student attitudes towards mathematics over a period of time; and also to use improved questions on the MPST that include more content areas, to capture student achievement in problem solving would be necessary.
3. An examination of the effects of various teacher deployment patterns on student achievement and attitudes towards mathematics would be useful, to investigate their effects on students achievement and attitudes to mathematics and the teachers, most especially the effects of the horizontal or vertical teacher deployment patterns on student achievement and attitudes.
4. An investigation of in-class peer grouping and student study-grouping strategies effect on student participation in learning should be conducted and to determine the effects of the grouping strategies on student achievement.
5. An investigation of the growth of student attitudes towards mathematics using a longitudinal study with a multi-point measures design, to inform us more about the growth of student attitudes and how they could be improved.
6. Different studies following quantitative and/or qualitative methodology could be conducted to fine grain the findings of this study.

7. An investigation of the relationships between instructional practices and attitudes towards mathematics and student achievement using a variety of measures to determine the attitudes and achievement.

8. Based on the results from the nine secondary schools included in this study, student attitudes towards mathematics significantly correlated with student achievement in mathematics problem solving. Although these results are significant, additional research using a greater number of schools in a variety of districts should be conducted to determine if these results generalize to other schools and geographic areas.

9. The results of the quantitative and qualitative study clearly demonstrate that the success of a school, as measured specifically by raising student achievement and the development of student positive attitudes towards mathematics could be achieved through a combined effort of teachers, the society, the school, and the students. The teachers make contribution through pursuing excellence and enhancing participation of the students as there was evidence from the sample schools that a positive school climate is associated with positive attitudes and higher achievement.

In conclusion, teachers are encouraged to help students in their classrooms to develop positive attitudes to their work and other personal qualities in all types of schools and promote gender equity among students. It should be noted that this study is only a first step in trying to understand the relationship between attitudes towards mathematics and achievement in mathematics in Uganda. The results of this study are reflective of the differences between HP- and LP-schools. The nature of teachers' practices in the sample schools were also found and appear related to the student attitudes and achievement. Since student attitudes towards and achievement in mathematics were identified then it could perhaps be easier for teachers to reflect on how to improve the teaching of mathematics to enhance student enjoyment of mathematics.

Teacher educators could explore ways to identify and to address antecedents of teacher practices in order to facilitate the building of positive student attitudes towards mathematics and to improve achievement in mathematics. Efforts must be made to raise student enjoyment of and achievement in mathematics through more student engagement, dealing with student fear of failure, making mathematics more relevant to everyday life, increase student initiatives in their learning, student acquisition of various skills and strategies to apply in further education, and developing student attitudes of confidence and mutual confidence. According to Raymond (1997:574), 'early and continued reflection about mathematics beliefs and practices, beginning in teacher preparation, may be the key to improving the quality of mathematics instruction and minimizing inconsistencies between beliefs and practice.' Furthermore, teacher classroom practices could be changed through teacher networks using programmes that meet the teachers' characteristics and conditions. It could be a good idea to get a group of teachers from HP- and LP-schools together to talk about what they do in the classroom. Teachers could to come away enriched with different ideas to try in their classrooms rather than working in isolation.

This study has contributed the much-needed information on student attitudes, achievement and the nature of teacher practices in Ugandan secondary schools.

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APPENDIX A1: STUDENT ATTITUDES TOWARDS MATHEMATICS INVENTORY (SATMI)

Thank you for accepting to participate in this educational research whose purpose is to investigate teacher practices, and secondary students' attitudes towards mathematics and their achievement in mathematics with an aim to understand and improve students' attitudes towards mathematics and achievement in mathematics.

A. 1. Case number...

2. Your gender: Male...Female...

3. Your age...years

4. School-type.... (Leave blank)

5. Your Mathematics grade in the Primary leaving Examinations (tick)

D1	D2	C3	C4	C5	C6	P7	P8	F9

B. On the following pages is a series of statements. There are no correct or wrong answers to these statements. The only correct responses are those that are true to you. The statements have been written in a way that allows you to show the extent to which you agree or disagree with the ideas expressed by crossing an appropriate response as: SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree. Suppose the statement is: Mathematics should be given more time on the timetable. As you read the statement, you will know whether you agree or disagree with it. If you strongly agree, circle SA after the statement. If you agree but with reservation, that is you do not fully agree, circle A. If you disagree with the idea, indicate the extent to which you disagree by circling D for disagree or circle SD for strongly disagree. But if you neither agree nor disagree, that is you are not sure circle U for undecided. Also if you cannot answer a question circle U for undecided. Do not spend too much time with any statement, but be sure to answer each statement. Work fast but carefully. Whenever possible, let the things that have happened to you help you make a choice.

THIS INVENTORY IS BEING USED FOR RESEARCH PURPOSES ONLY AND NO ONE WILL KNOW WHAT YOUR RESPONSES ARE.

1. Mathematics doesn't scare me at all................................ SD D U A SA
2. Generally I have felt secure about attempting Mathematics... SD D U A SA
3. I like Mathematics puzzles.. SD D U A SA
4. Mathematics usually makes me uncomfortable and nervous ... SD D U A SA
5. I'm not good at Mathematics....................................... SD D U A SA
6. Figuring out mathematical problems does not appeal to me.... SD D U A SA
7. It wouldn't bother me at all to take more Mathematics courses SD D U A SA
8. I am sure I could do advanced work in mathematics............ SD D U A SA
9. Mathematics is enjoyable and stimulating to me................. SD D U A SA
10. Mathematics makes me feel uncomfortable, restless, irritable, and impatient... SD D U A SA
11. I don't think I could do advanced Mathematics.................. SD D U A SA
12. The challenge of Mathematics problems does not appeal to me SD D U A SA
13. I haven't usually worried about being able to solve mathematical problems.. SD D U A SA
14. I am sure that I can learn Mathematics............................... SD D U A SA
15. When a Mathematics problem arises that I can not immediately solve, I stick with it until I have the solution........................ SD D U A SA
16. I get a sinking feeling when I think of trying hard Mathematics problems.. SD D U A SA
17. I am not the type to do well in mathematics...................... SD D U A SA
18. Mathematics puzzles are boring.................................... SD D U A SA
19. I almost never have got shaken up during a Mathematics test.. SD D U A SA
20. I think I could handle more difficult Mathematics............... SD D U A SA
21. Once I start working on a Mathematics puzzle, I find it hard to stop.. SD D U A SA
22. My mind goes blank and I am unable to think clearly when working Mathematics.. SD D U A SA
23. For some reason even though I study, Mathematics seems unusually hard for me... SD D U A SA

24. I don't understand how some people can spend so much time on Mathematics and seem to enjoy it…………………………….. SD D U A SA

25. I usually have been at ease during Mathematics tests……….. SD D U A SA

26. I can get good grades in mathematics………………………… SD D U A SA

27.When a question is left unanswered in mathematics class, I continue to think about it afterwards……………………………… SD D U A SA

28. A Mathematics test would scare me………………………….. SD D U A SA

29. Most subjects I can handle well, but I have a difficulty with Mathematics…………………………………………………… SD D U A SA

30. I would rather have someone give me the solution to a difficult Mathematics problem than to have to work it out myself. SD D U A SA

31. I usually have been at ease in mathematics classes………….. SD D U A SA

32. I have a lot of self-confidence when it comes to Mathematics. SD D U A SA

33. I am challenged by Mathematics problems I can't understand immediately ……………………………………………………. SD D U A SA

34. Mathematics makes me feel uneasy and confused……………. SD D U A SA

35. Mathematics has been my worst subject……………………… SD D U A SA

36. I do as little work in mathematics as possible……………….. SD D U A SA

Thank you for your cooperation

APPENDIX A2: SCALE SCORES

ANXIETY SCALE SCORES

SCORE	FREQUENCY		PERCENT		CUMULATIVE PERCENT	
SCH-TYPE	HP	LP	HP	LP	HP	LP
18.00	1	1	.7	1.0	.7	1.0
20.00	1		.7		1.3	
22.00		2		1.9		2.9
23.00	1		.7		2.0	
24.00	2	2	1.3	1.9	3.3	4.9
25.00	2	2	1.3	1.9	4.6	6.8
26.00	1	3	.7	2.9	5.3	9.7
27.00	1	2	.7	1.9	6.0	11.7
28.00	2		1.3		7.3	
29.00	1		.7		7.9	
30.00	1	2	.7	1.9	8.6	13.6
31.00		5		4.9		18.4
32.00	3	1	2.0	1.0	10.6	19.4
33.00	3	4	2.0	3.9	12.6	23.3
34.00	2	6	1.3	5.8	13.9	29.1
35.00	3	3	2.0	2.9	15.9	32.0
36.00	1	2	.7	1.9	16.6	34.0
37.00	1	4	.7	3.9	17.2	37.9
38.00	3	8	2.0	7.8	19.2	45.6
39.00	4	6	2.6	5.8	21.9	51.5
40.00	4	2	2.6	1.9	24.5	53.4
41.00	6	2	4.0	1.9	28.5	55.3
42.00	4	5	2.6	4.9	31.1	60.2
43.00	9	4	6.0	3.9	37.1	64.1
44.00	6	4	4.0	3.9	41.1	68.0
45.00	10	2	6.6	1.9	47.7	69.9
46.00	8	5	5.3	4.9	53.0	74.8
47.00	7	5	4.6	4.9	57.6	79.6
48.00	9	1	6.0	1.0	63.6	80.6
49.00	1	4	.7	3.9	64.2	84.5
50.00	7	3	4.6	2.9	68.9	87.4
51.00	10	2	6.6	1.9	75.5	89.3
52.00	10	3	6.6	2.9	82.1	92.2
53.00	4	3	2.6	2.9	84.8	95.1
54.00	7	1	4.6	1.0	89.4	96.1
55.00	2	1	1.3	1.0	90.7	97.1
56.00	5	1	3.3	1.0	94.0	98.1
57.00		1		1.0		99.0
58.00	6	1	4.0	1.0	98.0	100.0
60.00	3		2.0		100.0	
Total	151	103	100.0	100.0		

CONFIDENCE SCALE SCORES

SCORE	FREQUENCY		PERCENT		CUMULATIVE PERCENT	
SCH-TYPE	HP	LP	HP	LP	HP	LP
12.00		1		1.0		1.0
15.00	1		.7		.7	
20.00		1		1.0		1.9
21.00	1	1	.7	1.0	1.3	2.9
22.00	2		1.3		2.6	
23.00		1		1.0		3.0
24.00	1	2	.7	2.9	3.3	5.8
25.00		5		4.9		10.7
27.00		1		1.0		13.6
28.00	1		.7		4.0	
29.00	1		.7		4.6	
30.00	4	2	2.6	1.9	7.3	15.5
31.00	2	3	1.3	2.9	8.6	18.4
32.00	1	4	.7	3.9	9.3	22.3
33.00	1	3	.7	2.9	9.9	25.2
34.00	1	2	.7	1.9	10.6	27.2
35.00	5	2	3.3	1.9	13.9	29.1
36.00	1	5	.7	4.9	14.6	34.0
37.00	1	2	.7	1.9	15.2	35.9
38.00	3	3	2.0	2.9	17.2	38.8
39.00	4	7	2.6	6.8	19.9	45.6
40.00	2	4	1.3	3.9	21.2	49.5
41.00	2	3	1.3	2.9	22.5	52.4
42.00	7	2	4.6	1.9	27.2	54.4
43.00	5	1	3.3	1.0	30.5	55.3
44.00	6	9	4.0	8.7	34.4	64.1
45.00	5	4	3.3	3.9	37.7	68.0
46.00	6	5	4.0	4.9	41.7	72.8
47.00	9	3	6.0	2.9	47.7	75.7
48.00	4	2	2.6	1.9	50.3	77.7
49.00	11	5	7.3	4.9	57.6	82.5
50.00	6	5	4.0	4.9	61.6	87.4
51.00	9	2	6.0	1.9	67.5	89.3
52.00	7	3	4.6	2.9	72.2	92.2
53.00	7	1	4.6	1.0	76.8	93.2
54.00	7	3	4.6	2.9	81.5	96.1
55.00	5	1	3.3	1.0	84.8	97.1
56.00	7	1	4.6	1.0	89.4	98.1
57.00	6	2	4.0	1.9	93.4	100.0
58.00	2		1.3		94.7	
59.00	4		2.6		97.4	
60.00	4		2.6		100.0	
Total	151	103	100.0	100.0		

MOTIVATION SCALE SCORES

SCORE	FREQUENCY		PERCENT		CUMULATIVE PERCENT	
SCH-TYPE	HP	LP	HP	LP	HP	LP
22.00	1		.7		.7	
23.00		1		1.0		1.0
24.00		2		1.9		2.9
26.00	1		.7		1.3	
27.00	1	1	.7	1.0	2.0	3.9
28.00	1		.7		2.6	
29.00	1	1	.7	1.0	3.3	5.8
30.00	4	3	2.6	2.9	6.0	8.7
31.00		2		1.9		10.7
32.00	1	8	.7	7.8	6.6	18.4
33.00	1	2	.7	1.9	7.3	20.4
34.00	2	4	1.3	3.9	8.6	24.3
35.00	2	5	1.3	4.9	9.9	29.1
36.00	2	4	1.3	3.9	11.3	33.0
37.00	1	6	.7	5.8	11.9	38.8
38.00	3	3	2.0	2.9	13.9	41.7
39.00	6	8	4.0	7.8	17.9	49.5
40.00	4	9	2.6	8.7	20.5	58.3
41.00	10	4	6.6	3.9	27.2	62.1
42.00	6	2	4.0	1.9	31.1	64.1
43.00	10	9	6.6	8.7	37.7	72.8
44.00	14	5	9.3	4.9	47.0	77.7
45.00	9	4	6.0	3.9	53.0	81.6
46.00	10	8	6.6	7.8	59.6	89.3
47.00	7	4	4.6	3.9	64.2	93.2
48.00	8	3	5.3	2.9	69.5	96.1
49.00	12	2	7.9	1.9	77.5	98.1
50.00	8		5.3		82.8	
51.00	6		4.0		86.8	
52.00	8		5.3		92.1	
53.00	5	1	3.3	1.0	95.4	99.0
54.00	1	1	.7	1.0	96.0	100.0
55.00	2		1.3		97.4	
56.00	1		.7		98.0	
57.00	2		1.3		99.3	
58.00	1		.7		100.0	
Total	151	103	100.0			

ACHIEVEMENT IN PROBLEM SOLVING SCORES

SCORE	FREQUENCY		PERCENT		CUMULATIVE PERCENT	
SCH-TYPE	HP	LP	HP	LP	HP	LP
.00	13	19	8.6	18.4	8.6	18.4
5.00	7	16	4.6	15.5	13.2	34.0
10.00	12	7	7.9	6.8	21.2	40.8
15.00	9	9	6.0	8.7	27.2	49.5
20.00	4	10	2.6	9.7	29.8	59.2
25.00	13	3	8.6	2.9	38.4	62.1
30.00	9	7	6.0	6.8	44.4	68.9
35.00	12	5	7.9	4.9	52.3	73.8
40.00	11	2	7.3	1.9	59.6	75.7
45.00	12	1	7.9	1.0	67.5	76.7
50.00	7	1	4.6	1.0	72.2	77.7
55.00	9	5	6.0	4.9	78.1	82.5
60.00	8	6	5.3	5.8	83.4	88.3
65.00	4	1	2.6	1.0	86.1	89.3
70.00	4		2.6		88.7	
75.00	4	3	2.6	2.9	91.4	92.2
80.00	3	2	2.0	1.9	93.4	94.2
85.00	5	2	3.3	1.9	96.7	96.1
90.00	3	3	2.0	2.9	98.7	99.0
95.00	1		.7		99.3	
100.00	1	1	.7	1.0	100.0	100.0
Total	151	103	100.0	100.0		

APPENDIX B1: MATHEMATICS PROBLEM SOLVING TEST (MPST)

Question	Q.1	Q.2	Q.3	Q.4	Total
Marks					

STUDENT CODE …………......... SCHOOL CODE...

INSTRUCTIONS TIME: 1 hour

(a). Attempt all problems. All reasonable solutions are acceptable.

(b). All problems carry the same number of marks.

i) Write legibly, and show all your working steps clearly.

ii) Show all strategies you use and working in the answer sheets provided.

Question 1

A school is divided into lower, middle and upper sections. The change-of-lesson bell rings after thirty, forty and forty five minutes in the lower, medium and upper sections respectively.

a) Morning break falls when the bells ring at the same time. If the lessons in the lower and middle section start at 8:00 am at what time does break start?

b) The break lasts 30 minutes. After break, lessons start at the same time in the lower, middle ad upper sections. At what time will the three bells ring at the same time?

Question 2

Anthony, a school sports prefect, has to plan a football tournament involving ten schoolhouse teams. Each house-team has to play every other house-team once. What is the total number of games to be played that he has to plan for? Show clearly how you worked the total out.

Question 3

Children are seated around a table and pass round a packet of sixteen sweets. Ekanya takes the first sweet. Each child then takes one sweet at a time as the packet is passed around. Ekanya also receives the last sweet. Find three possible numbers of children seated on the table and how many sweets each one gets in each case.

Question 4

There are fewer than six-dozen eggs in a basket. If they are counted two by two there will be one left over. If they are counted three at a time there will be none left over. And if they are counted four, five, or six at a time, there will always be three left over. How many eggs are in the basket?

Thank you for your cooperation

APPENDIX B2: MARKING GUIDE FOR MPST

(a) A Generic Rubric for Scoring Open-Ended Problems

CRITERIA	SCORE	SOLUTION
• Attempts to extend the problem; contains a full complete solution; correct interpretation of problem; correct strategy identified and followed.	5	As given
• Starts with a correct interpretation of the problem; identifies correct strategies; gives a complete solution with minor errors.	4	
• Interprets the problem correctly starts with a correct strategy; follows some wrong steps; part correct solution.	3	As given
• Gives incomplete solution; shows some errors; starts with an appropriate strategy.	2	
• Begins with an inappropriate strategy; misunderstands the question; shows major errors; incomplete solution.	1	As given
• No attempt or response	0	Nil

(b) Each Solution Category, Indicators and Score

CATEGORY	INDICATORS	SCORE
OUTSTANDING	-full acceptable solution -accurate execution of strategy -appropriate choice of strategy -correct interpretation of problem	5
	-acceptable solution -accurate execution of strategy -appropriate choice of strategy -correct interpretation of problem	4
SATISFACTORY	-unacceptable solution -minor errors in execution of strategy -appropriate choice of strategy -correct interpretation of problem	3
	-unacceptable solution -accurate execution of incorrect strategy -inappropriate choice of strategy -correct interpretation of problem	2
INADEQUATE	-no solution, working abandoned -inaccurate execution of wrong strategy -inappropriate choice of strategy -incorrect interpretation of problem	1
NO ATTEMPT	Blank answer script	0

(c) Individual Scoring Rubric for Question One

CRITERIA	SCORE
Outstanding solution	
• A complete solution to the problem. A correct strategy, clear steps and a correct solution to the problem. Everything is correct. Full marks.	5
• Starts with a correct strategy. Completes the problem fairly well with minor errors. Shows the beginning of lessons after break, 10.30. Attempts at finding the time when the bells will ring together again.	4
Satisfactory solution	
• Shows correct strategy. Starts the problem appropriately. Lists the time sequences such as: Lower; 8→8.30→9.00→etc Upper; 8→8.40→9.20→etc Or any other approach.	3
• Indicates correct start of lessons 8.00. Attempt is made to interpret the problem and show the school sections and lesson times. Begins but fails to complete.	2
Inadequate solution	
• Some attempt is made, indicating a correct interpretation.	1
• **No attempt, leaves a blank page**	0

SOLUTION

Lower	Middle	Upper
30 min	40 min	45 min
10.30	10.30	10.30
11.00	11.10	11.15
11.30	11.50	12.00
12.00	12.30	12.45
12.30	1.10	1.30
1.00	1.50	2.15
1.30	2.30	3.00
2.00	3.10	3.45
2.30	3.50	**4.30**
3.00	**4.30**	
4.00		
4.30		

30 min	40 min
8.00	8.00
8.30	8.40
9.00	9.20
9.30	**10.00**
10.00	

2	30	40	45
2	15	20	45
2	15	10	45
3	15	5	15
3	5	5	5
5	5	5	5
	1	1	1

$2^3 \times 3^2 \times 5$ = 360 min. (6 hrs) So 10.30 +6 hrs = **4.30 pm**.

2	30	40
2	15	20
2	15	10
3	15	5
5	5	5
	1	1

$2^3 \times 3 \times 5$ = i2o min. (2 hrs). So 8.00 + 2 hrs = **10.00 am**. Break starts.

(d) Individual Scoring Rubric for Question Two

<table>
<tr><th>CRITERIA</th><th>SCORE</th><th colspan="2">SOLUTION</th></tr>
<tr><td>Outstanding solution</td><td></td><td colspan="2" rowspan="5">1 2 3 4 5 6 7 8 9 10
1- * * * * * * * * *
2 * * * * * * * *
3 * * * * * * *
4 * * * * * *
5 * * * * *
6 * * * *
7 * * *
8 * *
9 *
10 -
A total of 45 games.
Key: * shows a game played.
1...10 are the teams.</td></tr>
<tr><td>• A complete solution. Identifies a correct strategy. Follows correct steps, and obtains a correct answer of 45 games. Full marks.</td><td>5</td></tr>
<tr><td>• A fairly complete solution. Follows a correct strategy and follows correct steps. But does not get the final solution.</td><td>4</td></tr>
<tr><td>Satisfactory solution</td><td></td></tr>
<tr><td>• Uses a correct strategy. Follows wrong steps but obtains his/her correct solution.</td><td>3</td></tr>
<tr><td>• Correct strategy but does not complete the problem. Uses wrong steps.</td><td>2</td><td>Team, plays</td><td>No of teams</td></tr>
<tr><td>Inadequate solution</td><td></td><td rowspan="2">9
8
7
6
5
4
3
2
1</td><td rowspan="2">1
2
3
4
5
6
7
8
<u>9</u>
Total 45 games</td></tr>
<tr><td>• Some attempt is made at a solution. Shows some a wrong strategy to the problem.</td><td>1</td></tr>
<tr><td>• No attempt, leaves a blank page</td><td>0</td><td></td><td></td></tr>
</table>

(e) Individual Scoring Rubric for Question Three

CRITERIA	SCORE	SOLUTION
Outstanding solution		There is an even number of sweets. If Ekanya has to get the last sweet too there must be an odd number of children. So the possible number of children could be: 3, 5, 7, 9, 11, 13, 15, and not exceeding 16 otherwise some children would not get any sweets. Now, by trial and error if there are 3 children, each can get 5 sweets and one is left over that Ekanya can have. If there are 5 children, each child can have 3 sweets and one if left over that Ekanya can take. If there are 7, 9, 11, and 13 children, each child would get 2 remainder 2, 1 remainder 7, 1 remainder 5 and 1 remainder 3 respectively. This would violate the conditions of the problem. If there are 15 children, each would get one sweet and one will be left over that Ekanya can take. So the solution is: If 3 children, each 5, Ekanya 6 If 5 children, each 3, Ekanya 4 If 15 children, each 1, Ekanya 2.
• A complete solution is obtained. A correct strategy is identified. A correct procedure is followed and a correct solution is given, if 15 children each child gets one sweet and Ekanya two sweets. If there are five children, each gets three sweets and Ekanya four. And if there are 3 children, the each child gets five sweets and Ekanya six. Full marks.	**5**	
• A fairly complete solution. Identifies a correct strategy. Follows a correct procedure and obtained the possible number of children but not all the correct distribution of sweets. Obtains the solution: there can be 3, 5, or 15 children.	**4**	
Satisfactory solution		
• Identifies a correct strategy, if Ekanya is to have a last sweet and there are an even number of sweets there must be an ODD number of children. So there may be 3,5,7,9...children.	**3**	
• Some attempt is made to solve the problem using a correct strategy, perhaps drawing a diagram. But a wrong solution or a part solution is obtained. If each child gets one sweet and Ekanya two sweets, there will be 15 children.	**2**	
Inadequate solution		
• An attempt is made to solve the problem but a wrong strategy is used.	**1**	
• **No attempt, leaves a blank page**	**0**	

(f) Individual Scoring Rubric for Question Four

CRITERIA	SCORE	SOLUTION
Outstanding solution		The number of eggs in 6-dozen is 72 so there will be less than **72** eggs. Since when the number is divided by 2, one remains there must be an ODD number of eggs. The number must be a multiple of 3 since there is no remainder when divided by 3. The possible numbers: 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69. But it must also be odd so the possibilities reduce to: 3, 6, 9, 15, 21, 27, 33, 39, 45, 51, 57, 63, and 63. Now by trial and error. If the number is divisible by 4 and has a remainder 3 then it could be: 27, 39, 51 and **63**. If the number is divisible by 5 and has a remainder 3 then it could be: 33 and **63.** If the number is divisible by 6 and has a remainder 3 then it could be: 9, 15, 21, 27, 33, 39, 45, 51, 57, **63** and 69. The number that satisfies all these conditions is **63.**
• A complete solution is given. All the conditions are satisfied: the number is less than 72, it is odd, when it is divide by 2 one remains, when it is divided by 3 there is no remainder, when it is divided by 4, 5, and 6 there is always a remainder of 3. The number that satisfies all conditions named is **63**. Full marks.	**5**	
• A fairly complete solution. The strategy is correct. The steps are correct. There is recognition that the number is odds, divisible by 3 and when divided by 4, 5, or 6 there is always a remainder of 3. The final solution is not obtained.	**4**	
Satisfactory solution		
• A correct solution strategy identified. A correct procedure followed. Some part correct solutions. There is recognition that the number is an odd multiple of 3. So it could be 3, 9, 15, …	**3**	
• A solution is attempted using a correct strategy. There is recognition that there will be less than 72 eggs and an ODD number.	**2**	
Inadequate solution		
• An attempt is made to interpret the problem using a wrong strategy. Perhaps the number of eggs in 6-dozen is inferred as 72.	**1**	
• **No attempt, leaves a blank page**	**0**	

APPENDIX C: LESSON OBSERVATION PROTOCAL (LOP)

TEACHER: -----------------SCH. CODE--------------CLASS: -------------

NO. OF PUPILS IN CLASS: ----------------------DATE: ------------------

Time	Lesson Development	Teacher Activities	Student Activities	Comments

Guidelines for Classroom Observation

Describe completely what you observe in the lesson. You may wish to use the following categories as a guideline for the comments regarding Mathematics instructional practice.

LESSON DESCRIPTION (include the amount of time spent of the various components of the lesson and instructional format – whole group, small group and individual work for each):

1. Integrity of the mathematical activity.
2. Quality of the classroom discourse (students/teachers communicating mathematically).
3. Nature of Classroom process (student questioning, conjecturing, justifying, reasoning, building mathematical arguments, etc.)
4. Teacher's attention to and respect for student thinking.
5. Use of appropriate materials and tools, including activities and textbooks.
6. Use of technology, in particular calculators and/or computers, in mathematics lessons.
7. Students valuing the Mathematics they are doing.
8. Students demonstrating confidence in their own ability.
9. Students engaged in mathematical problem solving.
10. Students carrying out rules and procedures (e.g., emphasis on skills verses strategies)
11. Students doing Mathematics as a mechanical activity that involves "getting through" a textbook/workbook page.
12. Class size, arrangement, etc.
13. Availability of calculators and/or computers for use in instruction.
14. Other

APPENDIX D: TEACHER INTERVIEW GUIDE (TIG)

I am Opolot-Okurut, a Mathematics Education graduate student at the University of the Western Cape [UWC]. I am engaged in a research project to find out what happens inside Mathematics classrooms. The purpose of this study is to investigate teacher practices, student attitude toward and achievement in mathematics aptitude problems. I am interested in your perspectives and experience as a secondary mathematics teacher. The data will be analysed to gain an understanding of mathematics teacher practices in our classrooms. It is vital to establish the current teacher practices to inform future efforts to improve educational quality in the country.

A) I would like you to talk about general information on your school set-up.

1. How many mathematics teachers are you in the school? How is the Mathematics department organised? What do teachers do? Do you hold meetings? How often?

2. How many Mathematics lessons do you teach per week? Do you teacher another subject? Do you have periods? What is the teaching arrangement in the school?

B) Talk to me about your Mathematics students.

3. How many students are normally in your class? What are the characteristics of your Mathematics students? (Are they bright, less bright, troublesome etc?) Do some of your students fear to ask questions? To fail? To get it wrong in your class? (How do help these students?)

4. Do your students have a positive attitude toward Mathematics? Confidence about their Mathematics? (How do you help those that do not have those qualities? How do you develop their confidence in mathematics?"

5. Are any of your students who are anxious about Mathematics? (How do you deal with those?) Are your students motivated to learn Mathematics? Why or Why not? Do some of your students experience difficulties with Mathematics? (How do you diagnose? How do you help those?)

C) Talk to me about the lesson that you have just taught

6. Explain some specific issues/ occurrences that happened in the cause of the lesson.... WHY did you do what you did?

7. Is this your usual class organisational/arrangement set-up? (Do you sometimes use other class organisation/arrangements WHICH? and WHY?)

8. What is your overall impression and evaluation of this particular lesson, would you consider this lesson successful, unsuccessful? Why? What went according to plan, what didn't? If the lesson were taught again, what changes, if any, would you make?

D) I would like us to talk about your teaching of Mathematics in general

9. What are your views on Mathematics and how it should be taught? Are there practices in mathematics teaching in school that need changing? Do you think teachers in school can do much about this?

10. *Preparation and Planning*: Do you give time to preparation, planning, marking in getting ready to teach? Have attended any professional development activities in mathematics? Do you meet with other mathematics teachers in the school to discuss and plan curriculum and teaching approaches?

11. How much of the intended curriculum do you cover in the year? Do you sometimes loose instructional time during the year? What causes loss of time? What do you do about the lost time?

12. *Resources/Technology used in Instruction*: What teaching resources do you use? What textbooks do you use? Are they easily available to students? Do your students use log tables/calculators for Mathematics? What teaching other instructional resources do you use in your teaching?

13. *Classroom Organisation and Management:* Do you change your approach in any way for groups of different ability ranges? How? Do different approaches /strategies work for different groups of students?

14. In your opinion, what factors affect your Mathematics teaching practice? (support, knowledge, shortage of materials, interruptions, class size)

15. *Instructional Strategies*: How does the teaching of this class compare with your teaching of those classes you teach which I haven't seen today? What teaching methods have you used and found useful? Would you consider the lesson as representative of your teaching? Would it be a representative snapshot? If different from other lessons, how? Are there topics/areas that you find difficult to teach? Do you conduct reviews of the work covered? How often?

16. *Assessment and Evaluation of Students:* How do you assess your students? How often do you assign them homework? What is the Mathematics homework you assign your students for? Do you provide learners with feedback? What do you do when a student gives unexpected solution to a problem?

E). **Personal Information:**

17. Teaching experience? Highest educational qualification? Training institution?

APPENDIX E1: APPLICATION FOR ACCESS TO UNEB DATA ARCHIVES

MAKERERE UNIVERSITY
P.O Box 7062 Kampala Uganda
Cables: "Makunika"
Telephone: 256 - 41 - 532924

DEPARTMENT OF SCIENCE AND TECHNICAL EDUCATION, DOSATE

Your Ref:

Our ref.
0231.15.440

January 09, 2001

The Secretary
Uganda National Examinations Board
PO Box 7066
KAMPALA

Dear Sir,

RE. ACCESS TO SCHOOLS' 'O' LEVEL MATHEMATICS RESULTS RECORDS

I am a Lecturer in Mathematics Education in the Department of Science and Technical Education (DOSATE) - School of Education, Makerere University. I am a staff development fellow of Makerere University. I was granted a three years' study leave in July 2000 to pursue PhD studies at the University of the Western Cape, South Africa.

I have returned to Uganda for three months, to March 2001, to pilot the instruments for the main study to be conducted later this year. The title of my study is "Relationship between Teacher Instructional Practice, Student's Attitude and Achievement in Application-type problems in Mathematics in Ugandan Secondary Schools."

I am requesting for assistance to access the Secondary Schools' 'O' level results for 1999 to enable me draw up the sample of schools for this study from the ordinary level schools' population. I shall highly appreciate any assistance in this regard.

Thank you.

Yours faithfully,

Charles Opolot-Okurut

cc. HOD, DOSATE.

APPENDIX E2: CONDITIONS FOR ACCESS OF UNEB DATA

UGANDA NATIONAL EXAMINATIONS BOARD

P. O. Box 7066
Telephone: 286173, 286637/8, 221596
Fax: 221592
Telegrams: UNEB UGA KAMPALA
E-MAIL: uneb@swiftuganda.com
KAMPALA, Uganda.

OUR REFERENCE:
YOUR REFERENCE: CF/TD/13

10 January 2001

Mr Charles Opolot-Okurut
Makerere University
Dept of Science and Technical Education, DOSATE
P O Box 7062
KAMPALA

Dear Sir

RE: ACCESS TO UNEB DATA

I refer to your letter of 9 January 2001. The Board grants permission to research data under the following minimal conditions.

1. The data must be gathered and used in a way that no individual candidate or school can be identified from the records so obtained.
2. The records obtained must be for designated research purpose only.
3. Prior to publication, UNEB must be given a copy of the finished report.
4. The Board may refuse you access to some records if necessary.

By return of mail, please let me know if you would be willing to abide by the above conditions. Further, you will be requested to pay a fee of shs50.000/= (Fifty thousand shillings only) to accounts section before getting access to the data.

Yours faithfully

M B B Bukenya
Ag SECRETARY

APPENDIX E3: ACCEPTANCE OF CONDITIONS FOR ACCESS OF UNEB DATA

MAKERERE UNIVERSITY
P.O. Box 7062 Kampala Uganda
Cables: "Makunika"
Telephone: 256 - 41 - 532924

DEPARTMENT OF SCIENCE AND TECHNICAL EDUCATION, DOSATE

Your Ref: CF/TD/13

Our ref. 0231.15.440

January 15, 2001

The Ag Secretary
Uganda National Examinations Board
PO Box 7066
KAMPALA

Dear Sir

RE: ACCEPTANCE OF CONDITIONS FOR ACCESS TO UNEB RESEARCH DATA

I refer to your letter Ref. CF/TD/13 of January 10, 2001. I wish to express my willingness to abide by the minimal conditions laid down, in that letter, by the Board as requirements for access to UNEB research data.

I also accept to pay the fee of Ug. Shs 50,000/= (Fifty thousand shillings only) to the accounts section of the Board before getting access to the data.

Yours faithfully

Charles Opolot-Okurut
Lecturer, Mathematics Education

APPENDIX E4: PERMISSION TO ACCESS UNEB DATA

UGANDA NATIONAL EXAMINATIONS BOARD

P. O. Box 7066
Telephone: 286173, 286637/8, 221596
Fax: 221592
Telegrams: UNEB UGA KAMPALA
E-MAIL: uneb@ swiftuganda.com
KAMPALA, Uganda.

OUR REFERENCE: CF/TD/13

YOUR REFERENCE:

10 January 2001

Mr Charles Opolot-Okurut
Makerere University
Dept of Science and Technical Education, DOSATE
P O Box 7062
KAMPALA

Dear Sir

ACCESS TO UNEB DATA

You are hereby granted permission to collect the data you requested under the conditions you accepted. The Ag Deputy Secretary (Secondary) will help you have access to the data.

Yours faithfully

M B B Bukenya
Ag SECRETARY

cc Ag Deputy Secretary (S)

APPENDIX F: ACCEPTANCE OF RESEARCH PROPOSAL FROM UNCST

UNCST

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

Your Ref:..........................

Our Ref:...........SS.1290..

Date:......02 Feb., 2001.........

Mr. Opolot-Okurut Charles
Department of Science and Technical Education
School of Education
Makerere University
P. O. Box 7062
KAMPALA.

Dear Mr. Opolot-Okurut,

RE: **RESEARCH PROPOSAL: RELATIONSHIP BETWEEN TEACHER PRACTICE, STUDENT'S ATTITUDE TOWARD MATHEMATICS AND ACHIEVEMENT IN APTITUDE PROBLEMS IN UGANDAN SECONDARY SCHOOLS**

The above research proposal has been approved by the Uganda National Council for Science and Technology (UNCST) and cleared by the Office of the President. The approval will expire on **02 February, 2002**. If it is necessary to continue with the research beyond the expiry date, a request for continuation should be made to the Executive Secretary, UNCST.

Any problems of a serious nature related to the execution of your research project should be brought to the attention of the UNCST, and any changes should be submitted for UNCST's approval before they are implemented.

This letter, therefore, serves as proof of UNCST approval and as a reminder of your responsibility to submit timely progress reports and a final report on completion of the study.

Yours sincerely,

Julius Ecuru
for: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

LOCATION/CORRESPONDENCE

PLOT 6, KAMPALA ROAD
UGANDA HOUSE, 11TH FLOOR
P.O. BOX 6884
KAMPALA, UGANDA

COMMUNICATION

TEL: (256) 41-250499
FAX: (256) 41-234579
E-MAIL: uncst@starcom.co.ug
WEBSITE: http://www.uncst.go.ug

APPENDIX G1: RESEARCH CLEARANCE TO RDC KAMPALA

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

UNCST

Your Ref:............................

Our Ref:........SS.1290......

Date:...02 February, 2001....

The Resident District Commissioner
Kampala District
KAMPALA

Dear Sir/Madam,

RE: **RESEARCH CLEARANCE**

This is to introduce **Mr. Opolot-Okurut Charles** who would like to carry out a research entitled: **Relationship between Teacher Practice, Student's Attitude toward Mathematics and Achievement in Aptitude Problems in Ugandan Secondary Schools** for a period of **one year** from the date of this letter in your district.

The research project has been approved by the Uganda National Council for Science and Technology and cleared by the Office of the President.

I am requesting you to give the researcher the necessary assistance to facilitate the accomplishment of the study.

Your cooperation in this regard will be highly appreciated.

Yours faithfully,

Julius Ecuru
for: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

c.c. Mr. Opolot-Okurut Charles
School of Education, Makerere University
Kampala.

LOCATION/CORRESPONDENCE

PLOT 10, KAMPALA ROAD
UGANDA HOUSE, 11TH FLOOR
P.O. BOX 6884
KAMPALA, UGANDA

COMMUNICATION

TEL: (256) 41-250499
FAX: (256) 41-234579
E-MAIL: uncst@starcom.co.ug
WEBSITE: http://www.uncst.go.ug

APPENDIX G2: RESEARCH CLEARANCE FROM RDC KAMPALA

THE REPUBLIC OF UGANDA

OFFICE OF THE RESIDENT DISTRICT COMMISSIONER KAMPALA

P. O. BOX 352 KAMPALA.

Our Ref: ADM.38

Your Ref:

Date: 7th Feb., 2001

The District Education Officer,
Kampala City Council,
P.O. Box 7010,
KAMPALA.

RE: RESEARCH CLEARANCE

This is to introduce to you Mr. Opolot-Okurut Charles who would like to carry out a research entitled: Relationship between Teacher Practice, Students' Attitude toward Mathematics and Achievement in Aptitude Problems in Ugandan Secondary Schools for a period of one year in Kampala District, as per attached letter.

Uganda in general and the teaching profession in particular should greatly benefit from this research. Therefore, kindly give the researcher your maximum assistance.

Solidarity,

Cranimer Kalinda
RESIDENT DISTRICT COMMISSIONER/KAMPALA.

RESIDENT DISTRICT COMMISSIONER
P, O, BOX 352 KAMPALA

APPENDIX G3: RESEARCH CLEARANCE FROM DEO KAMPALA CITY COUNCIL

City Council of Kampala

TELEPHONE 231440 KAMPALA

IN ANY FUTURE CORRESPONDENCE
PLEASE QUOTE

City Education Officer's Department
P. O. Box 2649
Kampala
Uganda.

Your Ref.

Our Ref.

Date: 9th Feb. 2001

TO:

ALL HEADTEACHERS
KAMPALA CITY COUNCIL

RE: RESEARCH CLEARENCE

This is to introduce to you Mr. Opolot Okurut Charles who is conducting a research in our Schools.

You are requested to give the researcher maximum cooperation.

Galiwango A.S
for: CITY EDUCATION OFFICER

/co

APPENDIX G4: RESEARCH CLEARANCE TO RDC MPIGI

UNCST

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

Your Ref:...........................

Our Ref:.....**SS 1290**.....

Date:...02 February, 2001

The Resident District Commissioner
Mpigi District
MPIGI

Dear Sir/Madam,

RE: **RESEARCH CLEARANCE**

This is to introduce **Mr. Opolot-Okurut Charles** who would like to carry out a research entitled: **Relationship between Teacher Practice, Students' Attitude toward Mathematics and Achievement in Aptitude Problems in Ugandan Secondary Schools** for a period of **one year** from the date of this letter in your district.

The research project has been approved by the Uganda National Council for Science and Technology and cleared by the Office of the President.

I am requesting you to give the researcher the necessary assistance to facilitate the accomplishment of the study.

Your cooperation in this regard will be highly appreciated.

Yours faithfully,

Julius Ecuru
for: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

c.c. Mr. Opolot-Okurut Charles
School of Education, Makerere University
Kampala

LOCATION/CORRESPONDENCE

PLOT 10, KAMPALA ROAD
UGANDA HOUSE, 11TH FLOOR
P.O. BOX 6884
KAMPALA, UGANDA

COMMUNICATION

TEL (256) 41-250499
FAX (256) 41-234579
E-MAIL uncst@starcom.co.ug
WEBSITE http://www.uncst.go.ug

APPENDIX G5: RESEARCH CLEARANCE FROM RDC MPIGI

THE REPUBLIC OF UGANDA

OFFICE OF THE DEPUTY RESIDENT DISTRICT COMMISSIONER
MPIGI DISTRICT
P.O. BOX 172 MPIGI

Your Ref: RDC/ED/51.

Our Ref: .... *Date:* 25/9/2001

The District Education Officer,
MPIGI DISTRICT.

Dear Sir,

RE: RESEARCH CLEARANCE.

This is to introduce Mr. Opolot Okurut Charles who is planning to carry out re a research entitled (RELATIONSHIP BETWEEN TEACHER PRACTICE, STUDENTS' ATTITUDE TOWARDS MATHEMATICS AND ACHIVEMENT IN APTITUDE PROBLEMS IN UGANDA SECONDARY SCHOOLS) in this District.

Please avail him all the assistance he needs.

Yours Faithfully,

A. Ruhangalinda.
DEPUTY/RDC/MPIGI (HQRS).

CC. DISO/MPIGI DISTRICT.
CC. LC.V. CHAIRMAN/MPIGI DISTRICT.

APPENDIX G6: RESEARCH CLEARANCE FROM DEO MPIGI

TELEPHONE:17

THE REPUBLIC OF UGANDA

MPIGI DISTRICT COUNCIL
Education Department
P.O.Box 123
MPIGI

IN ANY CORRESPONDENCE ON
THIS SUBJECT PLEASE QUOTE NO...............

25th September,2001

To: All Secondary School Headteachers,
MPIGI District.

Re: **MR. OPOLOT OKURUT CHARLES(RESEARCHER)**

Mr.Opolot is doing research on RELATIONSHIP BETWEEN TEACHER PRACTICES,STUDENTS` ATTITUDE TOWARDS MATHEMATICS AND ACHIEVEMENT IN ATTITUDE PROBLEMS IN UGANDA SECONDARY SCOOL IN Mpigi district.

Please avail him all the assistance needed.

Male Busulwa Badru
FOR: D.E.O,MPIGI

For District Education Officer
P. O. Box 123, Mpigi

APPENDIX G7: RESEARCH CLEARENCE TO RDC MUKONO

UNCST

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

Your Ref:..........................

Our Ref: SS 1290 ....

Date:... 02 February, 2001

The Resident District Commissioner
Mukono District
MUKONO

Dear Sir/Madam,

RE: **RESEARCH CLEARANCE**

This is to introduce **Mr. Opolot-Okurut Charles** who would like to carry out a research entitled: **Relationship between Teacher Practice, Students' Attitude toward Mathematics and Achievement in Aptitude Problems in Ugandan Secondary Schools** for a period of **one year** from the date of this letter in your district.

The research project has been approved by the Uganda National Council for Science and Technology and cleared by the Office of the President.

I am requesting you to give the researcher the necessary assistance to facilitate the accomplishment of the study.

Your cooperation in this regard will be highly appreciated.

Yours faithfully,

Julius Ecuru
for: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

c.c. Mr. Opolot-Okurut Charles
School of Education, Makerere University
Kampala

LOCATION/CORRESPONDENCE
PLOT 10, KAMPALA ROAD
UGANDA HOUSE, 11TH FLOOR
P.O. BOX 6884
KAMPALA, UGANDA

COMMUNICATION
TEL (256) 41-250499
FAX (256) 41-234579
E-MAIL uncst@starcom.co.ug
WEBSITE http://www.uncst.go.ug

APPENDIX G8: RESEARCH CLEARANCE FROM RDC MUKONO

THE REPUBLIC OF UGANDA

OFFICE OF THE DEPUTY RESIDENT DISTRICT COMMISSIONER
MUKONO (H/Q'S)
P. O. BOX 366 MUKONO.

Our Ref: MISC/1
Your Ref: ....

Date: 5/07/2001

TO WHOM IT MAY CONCERN

MR. OPOLOT-OKURUT CHARLES

We wish to introduce to you Mr. Opolot-Okurut Charles who wishes to carry out a research entitled: Relationship between Teacher Practice, Students' Attitude toward Mathematics and Achievement in Aptitude Problems in Ugandan Secondary Schools.

His research project has been approved and cleared, a letter of which he will present to you.

Please accord him all the necessary assistance during his research period.

Office of the Resident District Commissioner
DATE 5.07.01
MUKONO DISTRICT
P. O. BOX 336, MUKONO

Deborah Mbabazi
DEPUTY RDC/MUKONO.

APPENDIX G9: RESEARCH CLEARANCE FROM DEO TORORO

TORORO LOCAL GOVERNMENT,
EDUCATION DEPARTMENT,
P.O. BOX 490,
TORORO.

Ref: Educ.220/1

19th February, 2001

Mr. Opolot-Okurut Charles
Makerere University.

Re: CLEARANCE TO CARRY OUT RESEARCH IN SECONDARY SCHOOLS IN TORORO DISTRICT.

This is to inform you that you have been authorised to carry out research in Secondary Schools in Tororo District as per your request.

Headteachers are requested to give maximum co-operation concerning the matter.

D. Mwasa-Nyote
for: DISTRICT EDUCATION OFFICER, TORORO.

FOR: DISTRICT EDUC. OFFICER.
-TORORO-

APPENDIX G10: RESEARCH CLEARANCE TO RDC WAKISO

Uganda National Council For Science and Technology
(Established by Act of Parliament of the Republic of Uganda)

UNCST

Your Ref:

Our Ref: **SS 1290** Date: **July 10, 2001**

The Resident District Commissioner
Wakiso District
WAKISO

Dear Sir/Madam,

RE: **RESEARCH CLEARANCE**

This is to introduce **Mr. Opolot-Okurut Charles** who would like to carry out a research project entitled " **Relationship between Teacher Practice, Student's Attitude ytoward Mathematics and Achievement in Aptitude Problems in Ugandan Secondary Schools** " between July 10, 2001 and February 2, 2002 in your district.

The Uganda National Council for Science and Technology has approved the research project.

I am requesting you to give the researcher the necessary assistance to facilitate the accomplishment of the study.

Your cooperation in this regard is highly appreciated.

Yours faithfully,

Julius Ecuru
for Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

c.c. Mr. Opolot-Okurut Charles
School of Education, Makerere University
KAMPALA

LOCATION/CORRESPONDENCE
PLOT 10, KAMPALA ROAD
UGANDA HOUSE, 11TH FLOOR
P.O. BOX [illegible]

COMMUNICATION
TEL: (256) 41-2504[illegible]
FAX: (256) 41-2345[illegible]
E-MAIL: [illegible]

APPENDIX G11: RESEARCH CLEARANCE FROM DEO WAKISO

Tel
IN ANY CORRESPONDANCE ON THIS SUBJECT PLEASE QUOTE NO

THE REPUBLIC OF UGANDA

Office of the District Education Officer

P.O. Box 7218
WAKISO
Date: 9 - 7 - 2001

WAKISO DISTRICT COUNCIL

Headteachers
Secondary Schools
Wakiso District

RE: RESEARCH CLEARANCE

I wish to introduce to you Mr. Opolot Okurut Charles who is conducting a research entitled Relationship between Teacher Practice, Students' Attitude towards mathematics and Achievement in Aptitude problems in Uganda Secondary Schools.

I am requesting you to accord him possible assistance and co-operation.

SSEKAMATTE M.S.
DISTRICT EDUCATION OFFICER

DISTRICT EDUCATION OFFICER
WAKISO DISTRICT

(All correspondence to be addressed to the Chief Administrative Officer)

APPENDIX H1: RECORDING SHEET FOR FIAC

TEACHER'S CODE……. TOPIC…………..CLASS………DATE………

Time/Min	*CATEGORIES*											
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APPENDIX H2 (a): Summary 10 X 10 Interaction-Matrix for HP-Schools

Cat.	1	2	3	4	5	6	7	8	9	10	Tot.
1	1	0	0	0	0	0	0	0	0	1	2
2	0	2	7	6	10	0	0	10	0	0	35
3	0	0	25	21	18	2	1	4	2	0	73
4	0	0	0	158	22	9	11	230	1	31	462
5	0	0	0	131	1578	41	3	2	21	31	1807
6	0	0	0	19	40	370	3	6	10	51	499
7	0	0	0	14	13	4	20	6	1	7	65
8	1	33	34	68	64	26	20	235	8	16	505
9	0	0	6	12	22	0	2	1	76	2	121
10	0	0	1	33	40	47	5	11	2	492	631
Tot.	2	35	73	462	1807	499	65	505	121	631	4200
%	.05	.83	1.74	11.0	43.02	11.88	1.55	12.02	2.88	15.02	99.99

APPENDIX H2 (b): Summary 10 X 10 Interaction-Matrix for LP-Schools

Cat.	1	2	3	4	5	6	7	8	9	10	Tot
1	0	0	0	0	0	0	0	0	1	0	1
2	0	6	1	6	6	15	2	3	0	2	41
3	0	0	17	6	8	1	0	6	0	0	38
4	1	0	0	98	10	1	3	234	1	22	370
5	0	2	0	116	1088	27	1	4	5	27	1270
6	0	1	0	30	23	291	1	10	1	38	395
7	0	0	0	6	12	4	15	0	0	6	43
8	0	29	19	73	90	21	16	240	4	14	506
9	0	0	1	4	6	2	0	1	18	0	32
10	0	3	0	31	27	33	5	8	2	555	664
Tot	1	41	38	370	1270	395	43	506	32	664	3360
%	.03	1.22	1.13	11.01	37.80	11.76	1.28	15.06	.95	19.76	100.0