ASPECTS OF GENDER

AND MATHEMATICS:

A CASE STUDY

OF SOME SECONDARY SCHOOLS

IN KENYA

Thesis submitted for the degree of

Doctor of Education

at the University of Leicester

by

Sylvia Nock BSc (London)

May 2001
Acknowledgements

God is good and He has enabled me to complete this work. Thanks are due to Professor Tony Bush and Dr. Marianne Coleman who started with me along the path of academic research and Professor Ken Fogelman who accompanied me to the completion of this work. I am grateful to Jackie who was always there for me; James, Rose and family who always supported and encouraged me, and my sister Pamela who is so proud of me. Particular thanks are due to the head teachers, teachers and students of my research schools, for without them this work would have been impossible. I hope that this finished work is worthy of them.
Abstract

"Mathematics is difficult and especially so for girls". The researcher had heard this but believed that it was success in examinations that proved more difficult for students rather than mathematics itself and that often girls underestimated their ability to achieve in this curriculum area.

This is a case study focussing on four secondary schools, with varying percentages of girls, in rural Kenya. Kenya, in sub-Saharan Africa, is a country where there is no universal primary education (UPE) and education is not compulsory. Whilst looking at attitudes of all students, the emphasis has tended to be on the girls.

The researcher believes that the evidence from these schools is sufficient to suggest that Kenyan schools should not necessarily accept the female prejudices against mathematics that research has found in first world countries. These findings both confirmed and contradicted areas of previous research on gender and mathematics.

Whilst the majority of mathematics' teachers were male, the results endorse the literature which shows that this does not disadvantage the female students. However, expecting to find the girls marginalised in a country where a pedagogy of difference exists, in a subject considered a male domain, the researcher found that this was not the case: these findings tended to corroborate those of Driver (1980), Parry (1997) and Mittelberg and Lev-Ari (1999) in that female students, when motivated, are able to cope with mathematics.

Many of the girls were enthusiastic about mathematics when they entered the secondary school and they were aware of the importance of mathematics for their future careers. The researcher was not able to ascertain that girls would perform better in a single-sex environment.

The researcher believes that it is the expectation of a high level of mathematics for all students, together with the intensive syllabus that causes most Kenyan students to perform very badly in the mathematics' examination at the end of secondary schooling.
# Contents

**Chapter I: Introduction**

- Background to the study ........................................ 1
- The English and Kenyan educational systems ................. 4
- Purpose of the study ............................................ 6
- Mathematics ....................................................... 7
- Achievement in mathematics ................................... 8
- Basic attitudes towards mathematics .......................... 9
- Mathematics as a male domain ................................ 10
- Mathematics for career opportunities ....................... 10
- Confidence ....................................................... 11
- Male domination ............................................... 11
- The culture of the school ..................................... 11
- 'Value-added' ................................................... 12
- Progression of study .......................................... 13
- Research questions ........................................... 14

**Chapter II: Literature review**

- Preview .......................................................... 15
- Education in Kenya ............................................ 16
- Girls' schooling ............................................... 22
- Gender ........................................................... 23
- Mathematics ..................................................... 25
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement in mathematics</td>
<td>30</td>
</tr>
<tr>
<td>Basic attitudes towards mathematics:</td>
<td></td>
</tr>
<tr>
<td>- Pupils' attitudes</td>
<td>33</td>
</tr>
<tr>
<td>- Teachers' attitudes</td>
<td>36</td>
</tr>
<tr>
<td>- Parents' attitudes</td>
<td>39</td>
</tr>
<tr>
<td>Mathematics as a male domain</td>
<td>39</td>
</tr>
<tr>
<td>Mathematics for career opportunities</td>
<td>41</td>
</tr>
<tr>
<td>Confidence</td>
<td>43</td>
</tr>
<tr>
<td>Male domination</td>
<td>48</td>
</tr>
<tr>
<td>The culture of the school</td>
<td>50</td>
</tr>
<tr>
<td>- Equal opportunities</td>
<td>50</td>
</tr>
<tr>
<td>- Schooling or education?</td>
<td>51</td>
</tr>
<tr>
<td>- Large classes</td>
<td>52</td>
</tr>
<tr>
<td>- Respect for the teacher</td>
<td>53</td>
</tr>
<tr>
<td>- Homework</td>
<td>54</td>
</tr>
<tr>
<td>The need for change</td>
<td>54</td>
</tr>
<tr>
<td>Overview</td>
<td>57</td>
</tr>
</tbody>
</table>

**Chapter III: Methodology**

- Reflective practitioner               | 60   |
- Grounded theory                        | 61   |
- Ethnography                            | 62   |
<table>
<thead>
<tr>
<th>Contents cont.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Action research</td>
<td>63</td>
</tr>
<tr>
<td>Case study</td>
<td>64</td>
</tr>
<tr>
<td>Research purposes</td>
<td>65</td>
</tr>
<tr>
<td>Areas of concern for the researcher</td>
<td>66</td>
</tr>
<tr>
<td>Research design:</td>
<td>68</td>
</tr>
<tr>
<td>- Research questions</td>
<td>68</td>
</tr>
<tr>
<td>- Relevant data</td>
<td>70</td>
</tr>
<tr>
<td>- Data collection</td>
<td>72</td>
</tr>
<tr>
<td>- Data analysis</td>
<td>73</td>
</tr>
<tr>
<td>- Construct validity</td>
<td>75</td>
</tr>
<tr>
<td>- Internal validity</td>
<td>76</td>
</tr>
<tr>
<td>- External validity</td>
<td>76</td>
</tr>
<tr>
<td>- Reliability</td>
<td>76</td>
</tr>
<tr>
<td>Choice of schools</td>
<td>76</td>
</tr>
<tr>
<td>Major tasks</td>
<td>78</td>
</tr>
<tr>
<td>Research tools:</td>
<td></td>
</tr>
<tr>
<td>- Documentary analysis</td>
<td>80</td>
</tr>
<tr>
<td>- Interviews</td>
<td>80</td>
</tr>
<tr>
<td>- Questionnaires</td>
<td>81</td>
</tr>
<tr>
<td>- Classroom observation</td>
<td>83</td>
</tr>
<tr>
<td>Limitations of the study</td>
<td>84</td>
</tr>
</tbody>
</table>
## Chapter IV: Evidence

### School A:
- Background information: 89
- First teachers' questionnaire: 90
- Students' questionnaire: 91
- The importance of mathematics: 92
- Perceived ability: 93
- Basic attitudes: 94
- Confidence: 97
- Mathematics as a male domain and male domination: 100
- Other issues: 103
- Second teachers' questionnaire: 106

### School B:
- Background information: 110
- Class visits: 111
- First teachers' questionnaire: 112
- Students' responses:
  - The importance of mathematics: 112
  - Perceived ability: 112
  - Basic attitudes: 113
  - Confidence: 114
  - Mathematics as a male domain and male domination: 116
<table>
<thead>
<tr>
<th>Contents cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other issues</td>
</tr>
<tr>
<td>Second teachers' questionnaire</td>
</tr>
<tr>
<td><strong>School C:</strong></td>
</tr>
<tr>
<td>Background information</td>
</tr>
<tr>
<td>Mock KCSE results, 2000</td>
</tr>
<tr>
<td>First teachers' questionnaire</td>
</tr>
<tr>
<td>Students' responses:</td>
</tr>
<tr>
<td>The importance of mathematics</td>
</tr>
<tr>
<td>Perceived ability</td>
</tr>
<tr>
<td>Basic attitudes</td>
</tr>
<tr>
<td>Confidence</td>
</tr>
<tr>
<td>Mathematics as a male domain and male domination</td>
</tr>
<tr>
<td>Other issues</td>
</tr>
<tr>
<td>Second teachers' questionnaire</td>
</tr>
<tr>
<td><strong>School D:</strong></td>
</tr>
<tr>
<td>Background information</td>
</tr>
<tr>
<td>Best/worst subjects</td>
</tr>
<tr>
<td>Reasons why students may find mathematics easy/difficult</td>
</tr>
<tr>
<td>- Finding mathematics easy</td>
</tr>
<tr>
<td>- Finding mathematics difficult</td>
</tr>
<tr>
<td>Perceived ability</td>
</tr>
<tr>
<td>Basic attitudes</td>
</tr>
</tbody>
</table>
## Contents cont.

Confidence 137  
Other issues 138  
Teachers' questionnaire 138  

**School E:**  
Background information 141  
Examination results, June 2000 142  
Teachers' questionnaire 143  
Students' questionnaire 144  
The importance of mathematics 144  
Perceived ability 144  
Basic attitudes 145  
Confidence 146  
Mathematics as a male domain and male domination 146  
Other issues 147  

### Chapter V: **Themes and further analysis** 148  
Education for social mobility and individual opportunity 148  
Pedagogy of difference 149  
Male teachers 150  
Indigenous education 151  
Gender differences 152  
Effects of the secondary school 153
### Contents cont.

- **Mathematics**  
  - Pupils' attitudes  
  - School A  
    - Positive aspects  
    - Negative aspects  
  - School B  
    - Positive aspects  
    - Negative aspects  
  - School C  
    - Positive aspects  
    - Negative aspects  
  - School D  
    - Positive aspects  
    - Negative aspects  
  - School E  
    - Positive aspects  
    - Negative aspects  
- Overview of the girls' results in the four Kenyan secondary schools  
- Female students who consider themselves to be weak at mathematics  
- Comparison of results with the private school
Contents cont.

Chapter VI: Conclusions

General responses 176
Possible marginalisation of girls 177
Research questions 179
Other features arising from the data 183
The way forward 184

Appendices:

Appendix A: Teachers’ Questionnaire (1) 187
Appendix B: Teachers’ Questionnaire (2) 188
Appendix C: Students’ Questionnaire 190
Appendix D: Amended Students’ Questionnaire 192
Appendix E: Teachers’ responses to questionnaire 1 (School A) 194
Appendix F: Teachers’ responses to questionnaire 1 (School B) 195
Appendix G: Teachers’ responses to questionnaire 1 (School E) 196
Appendix H: Comparison between the IGCSE and KCSE syllabi 197

References 199
Tables:

Table 1: Educational targets 17
Table 2: Students in the school (School A) 89
Table 3: How important do you feel maths is? 92
Table 4: Will knowing maths help get you a job? 92
Table 5: Percentages of students specifying that maths was important for their career as a reason for liking mathematics 92
Table 6: How good are you at maths? 93
Table 7: Do you have to be clever to do maths? 93
Table 8: Reasons for liking maths 95
Table 9: Reasons for disliking maths 95
Table 10: Can you understand how students can enjoy maths? 95
Table 11: Do you enjoy maths? 96
Table 12: Do you enjoy solving maths’ problems? 96
Table 13: Do you generally feel confident about maths? 97
Table 14: Do you feel confident about maths’ tests? 97
Table 15: Do you feel nervous when you look at a maths’ problem? 98
Table 16: Are you lucky when you do well in a maths’ test? 98
Table 17: Reasons for doing well in maths 99
Table 18: Reasons for doing badly in maths 99
Table 19: Do you understand new ideas quickly? 100
Table 20: Do you get most of your maths right? 100
Table 21: Do you see the point of most of the maths you do? 101
Table 22: Do you feel nervous if you are asked a question in class? 101
Table 23: Do boys like to beat girls at maths? 102
Table 24: Favourite topics in maths 103
Table 25: How long do you tend to spend on maths homework? 104
Table 26: Do you find maths easy if you work carefully? 105
Table 27: Percentages showing students responses to the questionnaire 105
Contents cont.

Table 28: Students in the school (School B) 110
Table 29: How good are you at maths? 112
Table 30: Do you have to be clever to do maths? 113
Table 31: Reasons for doing well in maths 115
Table 32: Reasons for doing badly in maths 115
Table 33: Responses that could be indicative of mathematics being a male domain 116
Table 34: Students in the school (School C) 119
Table 35: Mock KCSE mathematics’ results 120
Table 36: Difference between the maths’ grades and the overall mock mark 120
Table 37: Percentages showing students liking/disliking maths 122
Table 38: Reasons for liking maths 123
Table 39: Reasons for disliking maths 123
Table 40: Favourite topics in maths 125
Table 41: Percentages showing students responses to the questionnaire 126
Table 42: Students in the school (School D) 130
Table 43: Students’ best subjects 131
Table 44: Students’ worst subjects 131
Table 45: Reasons for finding maths easy 133
Table 46: Reasons for finding maths difficult 134
Table 47: Percentages showing students liking/disliking maths 136
Table 48: Reasons for liking maths 136
Table 49: Reasons for disliking maths 136
Table 50: Reasons for doing well in maths 137
Table 51: Reasons for doing badly in maths 138
Table 52: Students in the school (School E) 142
Table 53: Boy to girl ratios 142
Table 54: Percentages showing students liking/disliking maths 145
Table 55: The percentage of girls in each school 172
Table 56: Responses relating to ability in mathematics 172
Table 57: Responses relating to confidence in mathematics 173
Table 58: Responses relating to being nervous in mathematics 173
Table 59: Responses relating to enjoyment in mathematics 174
Table 60: Responses relating to understanding new ideas and finding maths easy 174
Table 61: Responses relating to achievement and understanding in mathematics 175
Table 62: KCSE topics that are not included in the IGCSE core syllabus 198

Figures:
Figure 1: Bar chart showing students who see the point of maths (School A) 156
Figure 2: Bar chart showing students always enjoying mathematics 157
Figure 3: Bar chart showing students who are always confident 157
Figure 4: Bar chart showing students who think they are lucky 158
Figure 5: Bar chart showing students who consider maths is too hard 158
Figure 6: Bar chart showing students who consider they are hopeless 159
Figure 7: Bar chart showing students who are nervous if asked a question 159
Figure 8: Bar chart showing students who think they are lucky (School B) 161
Figure 9: Bar chart showing students who consider maths is too hard 161
Figure 10: Bar chart showing students who consider they are hopeless 162
Figure 11: Bar chart showing students who are nervous if asked a question 162
Introduction

Aspects of gender and mathematics:

a case study of some secondary schools

in Kenya

Chapter I: Introduction

Background to the study

"Mathematics is difficult and especially so for girls". Having taught in secondary schools for over twenty-five years, mainly in England, the researcher had heard this comment many times, but did not agree. She found that it was success in examinations that proved more difficult for students rather than mathematics itself and that often girls underestimated their ability to achieve in this curriculum area.

Teaching mathematics in mixed comprehensive schools the researcher did not distinguish gender differences with regards to mathematics’ achievement. Certainly, many girls have said that they could never do the subject, but as many boys have been found to have difficulties in the mathematics’ lessons. The emphasis has been to affirm, to girls and boys alike, that they were capable of mathematics, though not all students will achieve the same level of success.

The need to write an assignment on a curriculum issue, as part of a master’s degree course, was deemed to be an ideal opportunity to examine the possibility of gender inequalities, and discover whether there was validity in the proposition that girls fared worse than boys in mathematics. That study evolved considerably and became the dissertation for the master’s degree (Nock, 1997).
That work, which was a case study in one mixed comprehensive school in Northwest London, U.K. found that there were gender issues arising in mathematics, often to the advantage of the males. The main conclusions were:

1. Parents accepted that mathematics is important for both girls and boys, but a greater percentage expected boys to continue beyond GCSE. The majority of the mothers of the students were not confident about mathematics and did not enjoy mathematics at school whereas the majority of fathers had enjoyed mathematics and felt confident about it at school.

2. Boys were more confident than the girls about mathematics, and the percentage difference between them increased as they progressed through the school.

3. Many of the students could not see the point of most of the maths that they did and as they were approaching their examination year when they should have been doing more homework many were doing less.

4. Except for the first year in the secondary school, most of the girls had problems understanding new ideas in maths quickly and only in the first two years did a majority of the boys enjoy solving maths problems.

5. There was a need to explore ways of presenting subjects so that males and females with their differing capabilities were exposed to the varying tasks in such a way that all gain expertise.

From her work, the researcher has found that girls and boys portray differing characteristics that are in many ways gender specific. Whilst recognising these issues, she found that one needs to treat each student as an individual, in order to help the boys as well as the girls to achieve their potential in this area.
The researcher started teaching at an international private school in Kenya in September 1998. Visiting local schools and talking with the mathematics' teachers she found that the teachers, without any prompting, suggested that students found mathematics difficult and especially the girls. However the situation in Kenya was more urgent. Whereas the results of students in the U.K. were improving and the girls were catching up with the boys, the mathematics' results in Kenya were extremely low. In the 1999 KCSE mathematics' examination the mean percentage for the nation was 12%. Also in Kenya, a pedagogy of difference exists which suggests that however hard girls work they will always be seen as inferior (Bennaars, 1998).

Originally, the intention had been for the researcher to be integrated into a local mixed school, teaching some classes, being involved in departmental discussions and generally encouraging all the girls in the school. After a few weeks the school situation rendered that impractical. The researcher also realised that as a full-time teacher she did not have the time to be so committed to another school and a different approach was taken. The research for this thesis was started in two other local Kenyan secondary schools and extended to two further schools with some input from the researchers' own school.

The literature was explored for material pertaining to the need for mathematics in the curriculum and male and female achievement in mathematics. The researcher looked for basic attitudes affecting achievement in mathematics and any perceived gender differences relating to the teaching and learning of mathematics in schools.
The data consisted mainly of completed questionnaires. Mathematics' teachers were given a first questionnaire with specifically gender related questions, and then the results of questionnaires given to students to ascertain their confidence and perceptions of the subject were analysed. There were conversations with teachers and head teachers and then a follow-up questionnaire was distributed to the teachers after the students' questionnaires had been examined.

Initially a single-case study of a school in England, this present work is a multiple-case study of some secondary schools in Kenya under the Kenyan system of education and a private school in Kenya following the English system.

The English and Kenyan educational systems

The 1988 Education Reform Act in England and Wales introduced the National Curriculum, with its four key stages, into the schools in those two countries. The majority of students start secondary school at the age of eleven, after six years of primary education, having completed key stages one and two. There are then five years of compulsory secondary education. The first three years encompass key stage three, and the two years at key stage four terminate with the GCSE examinations. There are then two optional years of sixth form study. Some schools may take students at thirteen for the final three years before the GCSEs.

The English 6-5-2-3 system was replaced in Kenya by the 8-4-4 system (eight years of primary education followed by four years of secondary education culminating in four years of higher education) in 1985 at secondary level.
The 8-4-4 system was an endeavour to move away from an academic system to one more suitable for Kenya’s needs (Morton 1998, p.204). The reverse has in fact happened, with the Kenyan syllabi being very academic, and many schools needing to open during holidays to complete the syllabus. The four years of Kenyan secondary education encompass the final three years of compulsory education in England together with an extra year; equivalent to the American and Canadian high schools, where the students graduate at the age of seventeen.

The school in Kenya, where the researcher teaches, is a private boarding school, taking students for three years to IGCSE (International GCSE). In England, students in secondary school are tested nationally at the end of the two key stages. The researcher’s school has no external testing other than the IGCSE examinations taken at the end of the three years. There is an entrance examination taken by the students before entry to the school.

Before entering a secondary school in Kenya, students will have taken the KCPE (Kenyan Certificate of Primary Education) examinations. Their test scores determine the schools to which they may apply for admission (providing that the fees can be paid). Three of the four schools (A, B and C) used by the researcher have an initial entry requirement of over 400 out of 700 marks (though students with lower marks may be accepted); for the fourth school (school D) students need over 470 out of 700 marks. School A is a day school, schools B and C accept day students and boarders whilst school D takes only boarders. The four schools are in the same town: a rural community 200 km north-west of Nairobi.
Kenya is divided into divisions for purposes of education and then sub-divided into districts. In the final year of secondary education the district sets a mock examination for the schools which is marked internally, a term before the nationally set and marked KCSE (Kenyan Certificate of Secondary Education) examinations. The scores of the KCSE indicate the type of higher education or university place that the student can apply for.

Together with external testing, internal monitoring and evaluation are the norm in English schools, with a view to assessing ‘value-added’ education. From September 1998, secondary schools are statutorily obliged to set and publish GCSE targets for the cohort moving into year 10. In the researcher’s school any monitoring is left to the discretion of the individual teacher or department. In the Kenyan schools, the aim is academic achievement in the form of examination results, and teachers are rewarded for good results as well as the students.

Purpose of the study
Mathematics is a compulsory subject in the English system to GCSE and the Kenyan system to KCSE. The nature of mathematics is such that many students in both countries, both male and female, have difficulties with the subject. The original purpose of this study was to look at attitudes towards mathematics at secondary school level to try and understand why there are so many difficulties with this subject. Within the Kenyan context there was an additional purpose of trying to understand why the students performed so badly in the national examinations.
Introduction

It may be asked: "Why is mathematics so important?" and this has been examined particularly in the light of equal opportunities which also raises the question of female students' reluctance to continue with mathematics when the subject is no longer obligatory. The culture of the school and the importance given to equal opportunities within the school may well determine how the female students regard themselves. Attitudes of parents, teachers and students will affect achievement, especially if they think that mathematics and the sciences are male domains. Levels of confidence and the issue of male domination in the classroom will influence school work as well as examination results.

All of these issues have been examined closely in the literature and in the schools researched in the study. The researcher has not presented any hypotheses regarding gender achievement in mathematics. Rather she wished to examine attitudes to the subject and the achievement of students: to see whether in these particular schools there were gender differences, and whether changes to ameliorate learning of mathematics for all students were possible.

Mathematics

Mathematics is not an easy subject. Failing to move onto multiplication and division from procedural counting, or being unable to use derived facts, inhibit many students from progressing in this subject area. The need to abstract from the natural world is a developmental stage that not all students are able to achieve. Many students fail to understand mathematics when many of the problems are outside their immediate environment.
In England, the emphasis now in the primary schools is on 'numeracy'. Secondary schools are reliant on the products of the primary school and it is hoped that with a greater expertise in numeracy, students will develop more quickly in the other areas of mathematics. In Kenya, there is no such movement at the present time. Questions about the use of calculators and computers are also not relevant to the Kenyan situation where all the students in the local schools are still using logarithm tables, but they will arise in the future.

In both countries, there have been schemes in mathematics to improve understanding and enhance enjoyment in the subject. SMP and SMILE have been two such schemes in England, and in Kenya 'New Mathematics' was adopted in 1964 but abolished in 1981 (Bogonko 1992, p.120). The level of interest may have increased, but Kenyans found that the levels of achievement did not improve (D'Souza 1987, p.112). Many of the textbooks from this era remain on the shelves in the mathematics departments.

Achievement in mathematics

There has been much research on mathematical achievement and 'more attention appears to have been given to international comparisons in mathematics than in other areas of the curriculum' (Robitaille and Travers 1992, p.687). During the 1960s and 1970s achievement surveys found that 'males outperformed females'. Studies during the 1980s and 1990s showed that these achievement differences between males and females were narrowing significantly in many countries (op. cit., p.691). Girls are presently seen to do as well as boys.
A new trend of boys' under achievement is now being highlighted in the developed world (see Evans, 1996). With no Universal Primary Education in Kenya and no free education, this situation of boys' underachievement does not arise at the moment.

There is a very large range of ability within a year group of students regardless of gender. The Cockcroft Report (1982) presented the findings of an enquiry into the teaching of mathematics in primary and secondary schools in England and Wales. The Committee found that already there was a 'seven year difference existing among 11 year olds in the understanding of place value' (¶ 342).

If we relate this to work in the secondary years, it means that the mathematical understanding of some pupils who transfer to secondary school at 11 is likely already to be greater than that of some pupils who have just left school at 16 (¶ 436).

Many of the teachers in the researched secondary schools considered that the large range of ability of students in their classes was a major factor inhibiting successful teaching with their students.

Basic attitudes towards mathematics

Mathematics appears to be a subject area where adults are likely to have "hang-ups" and negative attitudes. Already it has been found that whereas the fathers of students in one study enjoyed and were confident in mathematics, the mothers were not. Parents recognised the importance of mathematics and they expected their children to make the required effort. They did though have different expectations for their sons and daughters (see also Burton 1986, p.2). Teachers may also see it as being more important for the boys to succeed than for the girls.
Mathematics as a male domain

Certain sections of the literature reviewed were very emphatic about the nature of mathematics. There is a 'male monopoly of mathematics' (Spender 1986, p.59) and 'mathematics retains its image as a masculine domain' (Burton 1986, p.8). Is this the reason why more boys continue learning mathematics beyond the age of compulsory education? Mathematics is necessary for engineering and like occupations, which are considered to be male. Accountancy and economics, because of their mathematical associations are also deemed to be male, though increasingly women have qualified and been successful in these occupations. Whereas there are other gender issues involved in engineering, are women inhibited from accountancy and economics because of the mathematics involved? When making a choice for studying at a higher level, are women turning from mathematics because it is considered a male domain?

Mathematics for career opportunities

It is recognised that mathematics is a 'critical filter' to higher educational and career opportunities (Leder, 1990). In the U.K., North America and Australia many students, but especially women, are restricting future choices by not continuing to study mathematics. Some will try to enhance the situation at a later stage, by taking extra mathematics classes, but this may not be easy (Isaacson 1990, p.27). For the Kenyan student there are no options in mathematics. All students are expected to complete the whole syllabus. This includes topics that are not covered at GCSE level in the U.K. and are included in courses that are optional for students in North America. All Kenyan students learn calculus.
Confidence

Many girls display a lack of confidence in their ability to do mathematics (Joffe and Foxman 1986, p.43). For some children their confidence will be undermined, producing the phenomenon of 'learned helplessness' (Dweck and Bush, 1976). Generally, girls work hard and attribute failure to a lack of sufficient hard work, whereas boys put failure down to bad luck (Joffe and Foxman 1986, pp.42-43).

Male domination

Boys are deemed to be more vocal in the lessons, take the dominant places in the classroom and to take more of the teacher's time (see Mahony, 1985). Textbooks have been more male oriented (see Northam, 1986) and the teaching has been described as more likely to appeal to boys (see Walden and Walkerdine, 1986). So the girls in mathematics' classes have tended to be marginalised. This issue of the possible marginalisation of girls became a predominant theme in this work, and some detailed analysis was conducted showing that in these four Kenyan secondary schools the girls did not appear to be marginalised in the mathematics' classes.

The culture of the school

The Sex Discrimination Act, 1975, gave a legal framework of equal treatment for girls and boys in England and Wales, which has been absorbed into the organisation of schools. Varying initiatives in England, and elsewhere, have changed the traditional approaches to managing schools.
The differences in educational provision for girls and boys in Kenya have been great, though as far back as 1933 recommendations were made to reduce the disparities (Sifuna 1990, p. 129). The traditional approaches to managing schools are evidenced. Still the question may be asked: "Does the school give equal access to boys and girls in all aspects of the curriculum?" If the ethos of the school is one of male supremacy, then the possibility of girls achieving in a male-perceived area will be low.

'Value-added'

The pupils have established thought and work patterns by the time they arrive at the secondary school. They have their likes and dislikes with regards to the curriculum. In mathematics many of the methods taught by primary school teachers have become fixed in their minds and it is difficult, if not impossible, to change ways of working. In mathematics it is certainly possible for students to regress as they pass through the secondary school. Many others would seem to progress in a pre-determined manner, receiving results that could be anticipated on entry to the school.

If teachers are trying to give a 'value-added' education in the secondary school then they need the criteria for judging such an education. In England, the prediction of performance together with regular monitoring and evaluation is high priority. This is not the case in Kenya. Unfortunately it was not possible for the researcher to compare the KCPE and KCSE results, to ascertain the possibility of whether the students were receiving a 'value-added' education in mathematics.
The researcher was also looking for examples of 'good practice': teachers within the mathematics’ departments who were particularly effective in teaching female students. Single lessons of forty minutes with large classes and incomplete sets of textbooks gave little opportunity for such initiative, and it was left to responses to the second teachers’ questionnaire to illustrate possible 'good practice'.

Progression of the study

The original study (Nock, 1997) was a single-case study. It proved to be a pilot study for this later work. Schools A and B were originally chosen for this multiple-case study, with school C providing literal replication. The researcher was looking for evidence as to whether the girls were marginalised in the mathematics’ lessons, especially in schools A and B, but did not find it. The dominance of the boys may still have affected the attitudes of the girls and school D was then approached, as it was an all girls’ school achieving better results, to compare the girls’ responses. With four schools with differing percentages of girls, any evidence relating to girls’ attitudes to mathematics is more compelling and the researcher has reached conclusions that may well apply to other secondary schools in Kenya.

The schools have cited poor teaching and weak students as causes of the poor KCSE results. However, it appeared to the researcher that it was the syllabus content that could be to blame. Thus a close examination of the syllabus and examination papers was undertaken and compared with the mathematics deemed essential for success for students taking U.K. examinations.
Research questions

There have been no hypotheses to prove or disprove in this study. Rather, the following research questions have been asked:

- Do the mathematics' teachers portray any obvious gender bias?
- Are there gender differences in the ways the students see themselves in this curriculum area?
- Are the boys more confident than the girls and do they enjoy the subject more?
- Are there any evident reasons for the failure of these students in the KCSE examination?
- What are the differences between the students researched in the Kenyan system of education and the students in the private school where the students will be successful in their mathematics' examinations?

The data was gathered in the year 2000, during one academic year in Kenya, which starts in January. The teachers were given their questionnaire first; the students being allowed a little time to settle in. All the students' questionnaires in schools A, B and C were returned before the end of the first term. The students in school D completed their questionnaires half way through the second term. Though the second questionnaire for teachers was given to the schools in June, there was a poor response. A duplicate was taken into the schools in the third term. The researcher made her final visits to the schools as they were preparing for the KCSE examinations at the end of their academic year.
Chapter II: Literature review

Preview

There is a culture shock on first visiting some schools in rural Kenya. Many children in primary schools do not wear shoes. The floors of the classrooms may be rough earth. There may be no glass in the windows, so that when it rains the shutters are closed and the rooms are darkened. In one school visited, part of the school development plan for 1998 was to build a water borehole. For the year 2000, one of the aims was to furnish classrooms with a table and chair for the teacher. There was some attempt to make posters for the walls. In the secondary schools visited walls were bare, the students worked with texts similar to those used in the 1950s and 1960s in the U.K. and they used logarithm tables.

Considerable literature relating to issues involving attitudes to mathematics was published in the 1980s. In the 1990s research tended towards pedagogical methods and endeavouring to make mathematics “female-friendly” and though this research may be relevant to the Kenyan situation, the practicalities are not viable. Large classes, lack of resources and an extensive syllabus have channelled the teachers into a strictly “chalk and talk” method of teaching. Thus the literature reviewed may seem dated: the researcher using mainly the basic research on mathematical achievement and gender. She has first looked at the history of Kenyan education, the place of girls’ schooling and the issue of gender before examining mathematics, mathematical achievement and attitudes to mathematics together with literature relating to the culture of the school. The research questions were then revisited in the light of the literature.
Education in Kenya

Kenya is a developing nation with a colonial history. In the partition of Africa, Kenya became a British protectorate in 1895 and a colony in 1920, gaining independence in 1963. At the beginning of the third millennium, there is no universal primary education (UPE) or free education; and many will not have the opportunity for a secondary education. Kenya struggles to educate the youth of the country and it is necessary to look at the history of Kenyan education to understand some of the reasons.

The colonials did not leave a functioning educational structure in place for the Kenyans. During the colonial period, Kenyans were the ‘educational, social and economic underdogs’ (Bogonko 1992, p.42). Males were given a technical education ‘with a view to producing cheap African skilled labour’ (op. cit., p.22). A limited literary education was provided to others to enable them to ‘become the local administrators and clerks in the colonial administration’ (Sifuna 1990, p.53). Education was on racial lines, with ‘Asian and European children receiving an academic type of education’ (op. cit., p.117).

Previously, there had been indigenous education, which prepared the young for their role in the community, and was ‘guided by the principle of learning by doing’ (Sifuna 1990, p.14). There was also an Islamic tradition of education (Sifuna 1990, p.21) as the Arabs and Persians had brought Islam to the East African coast by 700 A.D. (Bogonko 1992, p.10).
Before and after the second world war, Kenyans undertook to start their own schools in an endeavour to overcome 'what they saw as a deliberate effort on the part of the administration to limit their educational opportunities' (Sifuna 1990, p.135). The self-help or harambee schools gave education to many children at primary and secondary level (op. cit., p.161) and many of these schools still exist.

A turning point in the development of schooling was the declaration in 1948 by UNESCO (the U.N. Educational, Scientific and Cultural Organisation) 'that education is a human right which could be denied to no child' (Bogonko 1992, pp.58-59). However, it was not until the late 1950s that the 'education revolution' really began in East Africa.

Kenya was a participant in the Conference of African States on the Development of Education in Africa, which was held in Addis Ababa in May 1961. This conference advanced the revolution 'by advocating not only the universalisation of primary education (UPE) but also the rapid expansion of secondary and higher education' (Njoroge and Bennaaars 1986, p.72; see also Sifuna 1990, p.78). The targets set at Addis Ababa were the following:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>40%</td>
<td>51%</td>
<td>71%</td>
<td>100%</td>
</tr>
<tr>
<td>Secondary</td>
<td>3%</td>
<td>9%</td>
<td>15%</td>
<td>23%</td>
</tr>
<tr>
<td>Higher</td>
<td>0.2%</td>
<td>0.3%</td>
<td>0.4%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 1: Educational targets

During the early 1960s the need for secondary education was seen as a priority by many governments of African nations (Njoroge and Bennaars 1986, p.78), and in Kenya, up to 1970 secondary education was given preference. After 1970 the emphasis shifted mainly to primary education (D'Souza 1987, p.43).

In 1973, a presidential decree had sought to provide free education to children, for six years of primary education (Sifuna 1990, pp.172-173), and this was introduced in 1974 (D'Souza 1987, p.32) but had proved impracticable (Sifuna 1990, pp.173-175). Despite continuing efforts Kenya along with other developing countries still does not have UPE. The percentage of the 1991 cohort reaching grade 5 was around 75%, girls having a slightly higher survival rate than the boys (World Education Report 1995).

Under colonial rule some Kenyans did benefit from the educational system as education was ‘a gateway to employment in the new occupations created by the colonial government and its associated enterprises’ (Sifuna 1990, p.124). After independence the education all Kenyans wanted was that previously offered to the Europeans and Asians. They valued the ‘utility importance of a literary education’ as ‘the reward system favoured a literary education, not a technical one’ (Bogonko 1992, p.45). The colonial influence has though persisted, as since independence the trend has been towards ‘an academic education for the fortunate few and practical or technical education for the large majority’ (Njoroge and Bennaars 1986, p.69).
The indigenous education had served an unchanging society and did not involve the learning of figures, reading or writing (Sifuna 1990, p.13). Islamic education, though distinctly literate in character, (Njoroge and Bennaars 1986, p.65) put little emphasis on certificates or diplomas (Sifuna 1990, p.27). Education is now regarded by many people 'as a mechanism for social mobility and individual opportunity' (Njoroge and Bennaars 1986, pp.74-75; see also Sifuna 1990, p.160). The Kenyan government was faced with 'a huge demand for schools of an academic nature geared mainly to the selective examination system and repetitive teaching methods' (Sifuna 1990, p.160). Many African children attend school 'in the hope of obtaining one day the much desired certificates that may open the door to a bright future' (Bennaars 1998, p.22). 'Education has become an economic asset, the value of which is ultimately determined by the market value of the certificate' (Njoroge and Bennaars 1986, p.138). The emphasis in schools has become 'the acquisition of examination-oriented knowledge' (op. cit., 1986, p.138), with 'undue emphasis being placed on certificates rather than skills' (D'Souza 1987, p.115). It is essential to complete each stage of schooling, take the required examinations and gain the certificate. Some students entering the private sector still take their KCPE (Kenyan Certificate of Primary Education) examinations or ULE (Ugandan Leaving Examinations).

After independence, Kenya had to choose the language to be used in the schools. 'English was preferred as a medium of instruction from the early years of primary education' (Sifuna 1990, p.164), unlike Tanzania, where Kiswahili is the medium of instruction and English a compulsory subject (D'Souza 1987, pp. 10-11).
The economic value of education has already been mentioned. After independence, the first education commission report of 1964 gave ‘manpower production as a major aim of education’ (Bogonko 1992, p.108). The government leant towards the sciences (op. cit., p.122, 124; see also D’Souza 1987, pp.95-96, 112). A literary education no longer sufficed.

Already, by 1967, ‘it became increasingly difficult for those with only secondary school education and university graduates of arts, humanities and social science faculties to find jobs in the modern sector’ (Sifuna 1990, p.167). After 1970, the aim of the government ‘revolved around developing more A-level mathematics, science and technology classes than arts courses’ (Bogonko 1992, p.123), though the dropout rate in A-level science streams was found to be ‘unreasonably and wastefully high’ (op. cit., p.129). There may not be the dropout of students under the present system, but the results in mathematics (see page 3) and sciences at the end of secondary schooling are very poor as the 1999 KCSE (Kenyan Certificate of Secondary Education) examination results revealed (Daily Nation, 2000c).

In the early 1970s there was an alarming problem of unemployment among secondary school leavers (Sifuna 1990, p.171) as the ‘the rate of expansion of schools outstripped the possibilities for employment that once existed for school-leavers’ (op. cit., p.83). ‘The corollary to a “right to an education” declared by the Division of Human Rights in 1976 for every citizen is “the right to a job”’ (D’Souza 1987, p.9) but this did not, and does not exist for many Kenyans.
Despite the rise in unemployment and curriculum reform, the 1970-1974 Development Plan indicated that the country was still not producing a sufficient number of students with mathematics and science qualifications to fill all existing and proposed places in the university to train in the scientific occupations. More engineers, technicians, medical doctors and scientists were needed. The weak base of mathematics and science teaching in secondary schools was also affecting recruitment into the civil service as well as into the private sector (Bogonko 1992, p.126).

There was a need to restructure the whole education system. The 8-4-4 system evolved from the recommendations of the Mackay Report of 1981 (Bogonko 1992, p.135). ‘Challenge for national development: The concept of the 8-4-4 system was aimed at responding to the challenge of national development and participation of youth in development’ (Sifuna 1990, p.179). However, the Kamunge Commission in its Report of March 1988, found the secondary school curriculum unreasonably extensive (Bogonko 1992, p.135) and the number of subjects to be examined at KCSE was reduced. The system was under review again (the Koech commission) and despite the hope for reform the number of subjects to be examined is again to be reduced (East African Standard, 2000b).

This thesis examines the attitudes of some students who are fortunate to receive secondary education. They are aware of the necessity of acquiring the necessary certificates, in this instance the KCSE examination certificate, but are struggling with the sciences and mathematics in particular.
Girls' schooling

In Kenya, as in other developing countries, girls may not always have access to schooling (Gipps, 1996). The previous pages, describing the development of education in Kenya, have not sought to distinguish between boys and girls. However, the education of boys eclipsed that of the girls. 'There was a steady demand for girls’ schools as African parents began appreciating the education of their daughters (Bogonko 1992, p.60), but ‘the first girls’ school to offer courses up to school certificate level was not opened until 1950' (op. cit., p.65). By the end of 1954 there were only two secondary schools for girls (p.71).

During the independence era, enrolment of girls in primary schools showed a healthy trend in both absolute numbers and in proportion. By 1990, they accounted for 49 percent of pupils in primary schools (Bogonko 1992, pp.113-114). By the late 1990's girls had a slightly higher survival rate than the boys at primary level, as previously stated (page 18).

The population of females enrolled in secondary schools rose steadily from 30 percent of the total pupils in 1971 to 37 percent in 1976 and 40 percent in 1982 (Bogonko 1992, pp.134-135). Bogonko has stated that ‘this underscored the inequality of opportunity for girls in secondary education which was still in play’ (pp.134-135). Emphasising the inequality, he stated that ‘in 1980 of the 154 government secondary schools having A-level science streams only 35, or 23 percent were for girls’ (pp.134-135). Of the 172,522 students who took the 1999 KCSE examination in mathematics, 46% were girls.
Some may not want an academic education for the girls. Among the Samburu of northern Kenya, and in other regions, girls may be withdrawn from school at the age of 12, in order to be trained to become good wives (Daily Nation, 2000b). In the Koranic schools many Muslims accept that there has been a serious neglect of women’s education though, in theory, Islam prescribes the pursuit of learning by both men and women (Sifuna 1990, p.22). The girls in this study may be considered to be privileged as they are receiving four years of secondary education.

Gender

Differences have been noted between the education of Africans compared with Europeans, and to some extent Asians, in Kenya. The racial implications are beyond the scope of this work. The reality is that Africans have had to struggle for an academic education, and the boys have gained more than the girls have gained. Has this been a practical issue of prioritising needs, or are there intrinsic differences between boys and girls that imply that an academic education is not needed for girls? It has been suggested that for some tribes this is the case. This thesis has looked at the issue of gender, and whether being a boy or a girl has a direct influence on their achievement in mathematics.

Acker (1994) in looking at gender issues wrote:

What is ‘the problem’ about gender? The debate is not straightforwardly about educational achievement. There is no pattern whereby girls consistently do worse than boys, and in some ways they tend to do better (p.90).
Mahony (1985) looked at the biological and cultural aspects and asserted that 'gender has more to do with actual or expected behaviour' (p.56), and that 'the gender identity of human beings varies from culture to culture (p.61).

For Bennaars (1998) gender refers to the basic differentiation between men and women. It originates from 'the biological given' and that 'as a norm it points to unity and diversity' (p.31); but in Kenya, girls were and to some extent still are considered inferior. The indigenous education incorporated a pedagogy of difference (Wamahiu 1996, p.48) and Bennaars informs us that 'girls' education in Africa continues to be plagued by a discriminatory pedagogy of difference' (1998, p.41). He says that the belief that:

Boys are more intelligent than girls prompts the girls to grow up believing that they are grossly inferior to boys, simply because they are girls (op. cit., p.41).

Girls must still be encouraged to make the best use of educational opportunities, but, according to this view, 'however hard one tries, girls remain what they are: radically different, and therefore inferior, incapable, powerless' (p.48). Wamahiu (1996) found that girls were disadvantaged by this pedagogy of difference both at home and in the school (p.46).

Though there are differences, gender is seen as part of the "feminist" debate that emphasises female inequality. Certainly in Kenya, where this pedagogy of difference prevails:

Any call for female empowerment tends to be perceived as a serious threat to male domination or as a foreign intrusion by western-oriented feminists (Bennaars 1998, p.41).
Throughout this work the researcher has endeavoured not to be "feminist" though being white distinguished her immediately as Western. In searching for differences, researchers look at ways in which the teaching of mathematics fails with all students (Burton 1986) and this thesis is an endeavour to help all students. However, being more aware of discriminatory practices may well have imposed a certain bias towards the female position on the part of the researcher.

Needless to say 'a pedagogy that is informed by a critical understanding of the socio-cultural context will be liberating as well as empowering' (Bennaars 1998, p.47). Both the girls and the boys will be 'liberated from stereotyped attitudes and perceptions' (op. cit., p.47). As Bennaars states:

When girls are truly respected and when they are fully educated as human persons within an ethical context of universal humanity, at that moment a genuine celebration of difference will occur (p.49).

Mathematics

Before colonisation in Kenya, education was either indigenous or undertaken in the Koranic schools. Mathematics was a part of the indigenous education which included 'arithmetic, combinations, geometry and the property of numerals' in various game forms (Bogonko 1992, p.3). 'Through taking part in games, the boys developed various numerical skills such as addition, multiplication and subtraction' (op. cit., p.4). In the Koranic schools arithmetic was taught together with reading and writing (p.11). In mathematics, one is indebted to the Muslims who introduced Arabic numerals and decimal notation. Arabs also made great advances in geometry, invented algebra and developed trigonometry (Sifuna 1990, p.19).
Kenyans, in seeking a better education, looked for one where English and mathematics were important subjects (Bogonko 1992, p.55; see also p.36). With manpower production as a major aim of education (page 20), more A-level maths and science courses were introduced into secondary schools. The difficulty in these subjects was seen in the large dropout rate (page 20), and the difficulty in producing enough students to fill the places at university (page 21).

Mathematics together with English are regarded as essential to a balanced curriculum at the primary and secondary levels in Kenya (Bogonko 1992, p.67), as in other countries; but mathematics is a subject where many find intrinsic difficulties. Professor C. S. Lewis (1955) admitted that he could never have gone far in any of the sciences 'because on the path of every science the lion Mathematics lies in wait for you'. Parts of mathematics he could do, 'but the moment calculation came in he was helpless' (p.111). The questions of using calculators and teaching the 'New Mathematics' aimed at aiding students in the difficult area of mathematics have raised considerable debate.

The major controversy surrounding calculator use 'concerns the degree to which emphasis on traditional mental and written calculation procedures should be reduced' (Ruthven 1995, p.22). The British government has pressed for a return to the traditional methods, with a reduced emphasis on the use of the calculator (DfEE 1997, Ch.2 ¶31). Hewitt (1996) looking at the traditional model of exercises based on repetitive practice (p.37) felt that that type of practice was designed 'to help students to stand still' (p.40).
In secondary schools, calculators can be an invaluable tool as they ‘embody mathematical ideas, making them available for exploration and analysis through interaction with the machine’ (Ruthven 1995, p.23). They are not available in the local Kenyan schools so this debate is still to come.

For Kenyans, ‘dissatisfaction was voiced with regard to the sudden introduction of innovations’ (D’Souza 1987, p.112). This was referring to ‘New Mathematics’ which was abolished when it was found that many pupils could not perform basic calculations (op. cit., p.112).

For a large number of students, algebra is the hurdle they cannot overcome. Lee and Wheeler (1989) suggested that some students decide that algebra just doesn’t make any sense, but that they ‘are unwittingly shielding themselves from the intellectual conflict that might push their understanding a step further’ (p.54). Lee (1997) found that her research students gave algebra very low status, thinking it was irrelevant and had no real use (Cassette 2).

Graph work is a hindrance for others. Ainley (1995) said that there is considerable research evidence to support ‘the perception of graphing as a difficult topic’ (p.51). Graphical calculators may hold the key to a breakthrough in this area but again not for Kenyan students in the near future. Certainly Ainley concluded her article by saying that traditional teaching methods ‘seem likely to perpetuate the perception of graphing as a difficult topic’ (op. cit., p.57).
Graphical calculators are increasingly the norm in the developed countries and Smart (1995) found that using graphical calculators 'led the girls to an unusually high level of confidence about their work' (p.37). Ruthven (1990) observed that 'regular use of a graphic calculator provides experience which is likely to increase both the competence and confidence of students' and that 'both these factors are particularly likely to improve the performance of female students' (p.49).

There is a need for greater understanding of the mathematics involved, but it has already been indicated that the purpose of education in Kenya has become the acquisition of certificates and diplomas (page 19). There is an overemphasis on the mechanical acquisition of knowledge, and in this context 'it does not seem to matter whether the knowledge in question is relevant or meaningful, as long as it is examinable' (Bennaars 1998, p.16). Adair (1985) found that executive heads of Britain's largest private and public industrial organisations placed weight on passing examinations at school, 'but more as a test of character than of intelligence' (p.31). He quoted:

To be successful in examinations of any kind means self-discipline, capacity to do unpalatable work, ability to concentrate and willingness to think about something other than yourself - all useful in any kind of situation and for any kind of person (op. cit., p.31).

The defence of the system appears to be that 'academic work does shape and examinations do test or reveal our natural ability to think analytically' (p.31). The researcher does not consider that this would be sufficient to motivate teachers and students during the years of secondary education especially in mathematics.
For the Kenyans, under the indigenous system 'because what they learnt was also of utility to them, children did not need much motivation to learn' (Sifuna 1990, p.11). 'Traditional education reminds us of the importance of realism in education, involving children in real-life situations' (op. cit., p.14). Nunes (1997) found that street children in Brazil could manipulate mathematical concepts in their heads, the difficulty was the written form (Cassette 3). 'The Western school system does not deal with the realities of children’s time and environment - the realities of life' (Sifuna 1990, p.14). In mathematics many students do not see the relevance of the work they are doing. Burton (1986) talks of 'the intrusion of any real-world facts' whilst stating that it is 'beneficial both to the mathematics and to the pupils' (p.15). Certainly mathematics has tended to be conceptualised in the classroom, and when attempts have been made to concretise the work, teachers have come unstuck (see Keital 1989, p.58 and her experience in a lesson on “ratio and proportion”).

In the research schools the teaching follows the traditional textbook approach, which is seen to disaffect and disillusion girls who endeavour to understand their mathematics (see Boaler, 1997). The boys under such a system 'come to regard mathematics’ learning as a system of rule following and rote learning’ (p.293).

Mathematics is considered important but there are many difficulties inherent in the subject as have been shown. Understanding is deemed by many to be necessary, but in Kenya it is the taking of and being successful in external examinations that is all-important.
Achievement in mathematics

According to a headline in a Kenyan national paper: "Maths is where pupils flunk" (Daily Nation, 2000a). The article was describing the poor results in the KCPE (Kenyan Certificate of Primary Education) mathematics' examination. The results at the end of secondary education further reflect the difficulty of the mathematics' examinations in the Kenyan system. The results of the 1999 KCSE examinations were 10 percent for girls, 14 percent for boys (Daily Nation, 2000c).

Levels of achievement in mathematics in the developed countries have been concerns for many years, and much of the research has centred on gender differences. Girls' participation and achievement in mathematics became an issue in the United States of America in the 1960s and in 'the 1970s an equivalent interest began to be demonstrated in the United Kingdom' (Burton 1986, p.1). Whilst both girls and boys find mathematics difficult, 'fewer girls than boys achieve a very high level of attainment' (Scott-Hodgetts 1986, p.63). Hanna's meta-evaluative studies (1994) proved 'that boys generally outperform girls in the fields of mathematics, science and computer studies' but her analyses 'reveal that achievement differences observed across countries are much greater than gender differences'. Brusselmans-Dehairs and Henry (1994) found that:

In some countries, girls outperform boys from other countries which leads to the conclusion that important progress in mathematics achievement might be expected (for boys and girls) if the teaching conditions were modified (p.354).

In a study in Singapore, Kaur (1990) found that 'boys achieved better results than the girls in mathematics' (p.111).
Girls’ achievement is not always less than the boys: Driver (1980), researching recorded examination results from schools in England, found that in English language, maths and science the West Indian girls tended to get higher average results than the West Indian boys (p.112). Parry (1997) found similar results in her research on students in the Jamaican secondary education system.

In England and Wales, amongst native students, appendix 2 to the Cockcroft Report (1982) highlighted gender differences in mathematical performance between boys and girls. Jones and Smart (1995) affirmed this by stating that ‘it appeared to be that girls were underachieving by comparison with boys at secondary school level’ but that ‘at present there was very little difference in attainment at this level’ (p.164). By 1996 a British report claimed that ‘the only major subject in which girls perform significantly less well than boys is GCSE physics’ (HMSO 1996, p.6).

The differences in levels of achievement were found more particularly at the end of secondary schooling and amongst the higher achievers. The Assessment of Performance Unit (APU) 1980 survey of mathematics in schools (in the U.K.) found that ‘gender differences in performance were minimal in most topic areas except in the top ability bands’ (Shuard 1986, p.35; and quoted in Jones and Smart 1995, p.160). Brusselmans-Dehairs and Henry (1994) found internationally that:

Differences in results in science and mathematics according to gender are more important at the highest grade levels than at the lowest ones... In all of the countries, differences are consistently greater at the end of schooling (p.354).
More boys in the U.K. were entered for the higher level examination papers: Burton found that figures indicated 'a differentiated entry at sixteen plus', girls being entered for the Certificate of Secondary Education (Burton 1986, p.4). Jones and Smart (1995) almost ten years later found that a greater percentage of boys were entered for the higher tier of the GCSE, girls being entered instead for the intermediate tier (p.161).

Walden and Walkerdine (1986) found 'a greater preponderance of boys among the high scorers' (p.123). They also examined the total distribution of results. Looking at the difference in distribution of girls' and boys' scores as well as the difference in their mean scores, they found 'a bigger variance for boys' in many areas of mathematics (op. cit., p.123). Bielinski and Davison (1998) also recognised this 'phenomenon of gender differences in variability' (p.456) and went on to conjecture that 'easy items would be more difficult for males than for females and that 'difficult items would be more difficult for females than for males' (op. cit., p.459). Shuard (1986) found that 'the questions at which the girls did significantly better were easier questions than those at which the boys did significantly better' (p.31). APU tests have shown that 'at age 11, there is a tendency for more boys than girls to be in the bottom 10 percent in most topics' (Joffe and Foxman 1986, p.48). This suggests a tail of boys at both ends of the ability range. In the secondary school it has been suggested that this is not just a matter of ability but underachievement. These low-achieving boys have not been regarded specifically in this work.
One has been looking at the issues of gender and achievement in mathematics. The length of schooling that students have received prior to the examinations may also affect results. Summer babies may lose up to a year of schooling. Massey, Elliott and Ross (1996) confirmed the effects of birth-dates, and remarked that 'the size of the effects observed appeared similar to those associated with gender' (p.129). This is not relevant in the Kenyan situation as the school year begins in January and the KCPE examinations are at the end of eight completed years of primary education, the KCSE examinations after a further four years.

Basic attitudes towards mathematics:

- Pupils' attitudes

The subject of mathematics invariably invokes strong feelings. Various research projects have been instigated to look at pupils' attitudes to mathematics. The Assessment of Performance Unit (APU) regarded 'the thoughts and feelings of pupils towards activities as an important feature of their learning' (Joffe and Foxman 1986, p.38). Part of the concern was to incorporate a positive approach to subjects as part of the educational goals of a school (op. cit., p.38).

Students may find mathematics difficult, some may enjoy mathematics and many expect it to be useful. These may affect written test performance as well as participation in class. The APU findings have not revealed direct links between 'pupils' perceived difficulty, usefulness and enjoyment of mathematics and their written test performance' (p.39). The findings did suggest that 'actual participation in mathematics appeared to be connected to its usefulness rather than whether it was easy or difficult, or whether they enjoyed it' (pp.41-42).
Enjoyment of mathematics seemed to be more important among younger pupils (Joffe and Foxman 1986, p.42). As for its usefulness: "boys of 15, rated mathematics as more useful than the girls did" (op. cit., p.42). Mittelberg and Lev-Ari (1999) found in their research with Israeli Jewish and Arab youth that the largest percentage expecting to use mathematics in the future were the Arab girls (p.82).

The First International Mathematics Study (FIMS) in 1964 found that:

Data on students' attitudes towards mathematics indicated that 13-year olds in all of the participating countries had a more positive view of mathematics as a process than did the senior students... They also rated the importance of the role of mathematics more highly (Robitaille and Travers 1992, pp.691-692).

In looking at children's attitudes, Shuard (1986) found 'little difference between girls' and boys' enjoyment of mathematics or their perception of its usefulness, but there were significant differences in the opinions of boys and girls on how difficult they found mathematics' (p.23). This will be developed later in the section on confidence (page 45).

Participation in lessons may reveal basic attitudes to the subject. Galton and Delamont et al. whilst reviewing data for the ORACLE Project were confronted by the 'disturbing findings' that 'most girls are uninvolved in maths lessons and do very little work' (1985, p.174). Neither mathematics nor gender issues had been highlighted in the original organisation of the research which was concerned with the transition from the primary to the secondary school. Walden and Walkerdine (1986) also did research on this transitional stage.
They were concentrating particularly on mathematics and 'how children cope with different school practices when mathematics becomes a more discreet area of the curriculum' (p.122). They found that 'children are constructed as good or poor at mathematics and that this has material effects on the way in which they see themselves in relation both to their own work and the other children' (op. cit., p.137).

The APU findings suggest that differences between boys and girls 'both in their attitudes to mathematics and in their performance, have been firmly established by the time the pupils leave their primary school’ (Joffe and Foxman 1986, p.49). Shuard (1986) found that many girls already feel that they are failing in mathematics when they arrive at the secondary school (p.24).

Driver (1980), in his research on West Indian children, considered the crucial factor to be age but his findings were different. He found that even though the West Indian children may perform badly in the primary school they pulled ahead after entering secondary school (p.112). Parry (1997) found Jamaican girls largely outperforming boys at both primary and secondary level (p.224). She quoted a teacher who found that it was only when examinations approached that the boys began to apply themselves (p.227).

As already mentioned (page 29) Boaler (1997) found a large proportion of the girls were disaffected and disillusioned with their school mathematics, but this was due to the type of approach to mathematics in the school.
Whitelaw et al. (2000) in their study in one English school (during the academic year 1995/6) found that 'as many boys progress through the school their attitude towards academic success deteriorates' (p.99). This does not bode well for the girls in the same school who 'as they got older, became firmer in their views that they did not work harder than the boys' (p.99). Their study and the publication of the data in 2000 is important in that gender and age are still considered important research areas in the new millennium.

- Teachers' attitudes

What effect does the teacher have on the pupils? Crook and Briggs (1991) considered that teachers all had their “bags and baggage” which will be conveyed to their pupils. They perceived a marked lack of confidence in many student teachers when studying mathematics education, and had encountered similar attitudes in primary teachers and children (p.10). Scott-Hodgetts (1986) found that ‘most primary teachers have a low level of mathematical confidence’ (p.71). She suggests that ‘it is not girls’ performance that is the problem, but teachers’ interpretation of their performance’ (op. cit., p.63). Burton (1986) reported that the teacher is a major factor affecting female participation in mathematics. Teachers’ ‘awareness of and sensitivity to the effects of their behaviour on pupils appears to be crucial’ (p.2). Thompson’s work (1984) considered the relationship between teachers’ conceptions of mathematics and their teaching. She found that teachers’ conceptions about their students and the social and emotional make-up of their class ‘appear to play a significant role in affecting instructional decisions and behaviour’ (p.42).
Fennema (1990) emphasised that 'the decisions that teachers make have a strong influence on what their students learn and how they feel about themselves as they learn' (p.170) and girls especially will be influenced. Rodgers (1990) went so far as to say: 'The teacher's high expectation of the student's success facilitates learning and the reverse, perceived underestimation, can hinder learning' (p.30). Walden and Walkerdine (1986) appear isolated when they considered that girls did not accept the teacher’s definitions of their ability unequivocally’ (p.141). Jones and Smart (1995) stated that: ‘girls in particular seem to be affected by the teacher’s opinion of their mathematical ability’ (p.161). They seek a personal interaction with the teacher (Burton 1986, p.11), they are generally more concerned about adult approval (Scott-Hodgetts 1986, p.67). Interestingly, Shuard (1986) found that ‘questions at which girls did significantly better were ranked by teachers as being more important’ (p.31). Acker (1994) endorsed the teacher’s role, and emphasised the negative aspects in that ‘many studies in the gender and education literature imply that teachers play an important part in the thwarting of girls’ potential’ (p.90). Wamahiu (1996) quoted an example where a male mathematics’ teacher in Rwanda deliberately called weaker girls to the blackboard, making comments and allowing boys to comment on their inability to complete a task (p.55).

Teachers also have an effect on their male pupils. Clare (1996) implied that ‘boys do less well in school than girls because teachers are prejudiced against them’. Dweck and Bush (1976) stated that ‘teachers consistently evaluate boys less positively on conduct, nonintellectual personal qualities and motivation’ (p.148).
The preponderance of male teachers is not necessarily prejudicial to the female students. Koehler (1990) found that whereas 'some believed that students would perform better when taught by a teacher of the same sex, research has indicated that this is not necessarily the case' (p.130). Mittelberg and Lev-Ari (1999) found the majority of male teachers did not disadvantage the Arab females in Israel (p.88).

At a higher level, Rogers (1990) looked at the State University of New York College at Potsdam, USA, which has a higher percentage of undergraduate mathematics students than any other college, at least 20% compared with less than 1%, of whom many were women. Expecting to find a predominantly female staff, Rogers found 'in a department of 15 staff, only one was female' (p.41). 'Gender does not appear to be at all a factor in their teaching, neither directly or indirectly' (p.45). One teacher in particular had many women on his courses. This teacher told his students:

They are all capable of learning mathematics, provided that they are prepared to work hard. He sees his job as identifying 'the needs and level of understanding of his students and finding a way of helping them learn what they need to know' (p.43).

Dweck and Bush (1976) reported that 'male teachers were more apt than females to give feedback that clarified the student's misunderstanding' thus 'discouraging attributions to lack of ability on the part of the girls' (p.155). This accords with the concept of a “pedagogy of caring”. Bennaars (1998) has advocated ‘a pedagogy of caring, a pedagogy based on the ethic of care. It implies an approach to education that shows genuine concern for the learner’ (p.54).
- Parents’ attitudes

Parents’ attitudes will also affect their children’s participation in mathematics. Girls who continue with an interest in mathematics appear to enjoy more support and encouragement at home especially in the earliest years (Burton 1986, p.2). Kelly et al. (1986) explored the extent to which parental opinion constrains the ability of schools to influence children’s gender roles. They found that ‘parents had slightly higher educational aspirations for their daughters than their sons’ (p.94), ‘but that may well reflect the different labour market for girls and boys’ (p.94) at a time when boys had no difficulty finding employment. In Kenya, the researcher has heard similar sentiments expressed: “Girls need the education for they would not be able to advance in any other way”.

Mathematics as a male domain

There have been increased educational opportunities available to both males and females, yet ‘sex-stereotyping of certain areas of the curriculum persists’, and ‘academic success, it seems, particularly in mathematics, still tends to be associated with the male role’ (Leder 1986, p.81). Eales (1986) noticed that ‘the general message which some girls accept is that maths is a male domain’ (p.165).

Mahony (1985) noted that ‘the context and the language of the work is generally male oriented’. Northam (1986) examined a number of maths books and found that ‘the fading presence of girls in these books parallels the decline in girls’ involvement and achievement in maths between infant school and GCE ‘O’ and ‘A’ level examinations’ (p.110).
Northam noted ‘a clear tendency in the books studied to define mathematics as the
province of males, especially adult males’ (op. cit., p.116). Wamahiu (1996)
found that women and girls were particularly absent from mathematics oriented
textbooks (p.55), and Koehler (1990) found that boys’ names were used more,
they were more involved in “action”, and applications in careers were most often
white and male (p.130).

Whilst deploring the situation Mahony (1985) stated that ‘no straightforward links
can be made between biased, sexist material and girls’ alleged underachievement’
(p.15). Both the language and context of textbooks is male-dominated in other
areas of the curriculum such as English and modern languages, and ‘the
curriculum is no less biased in favour of males’ (p.15), yet girls are high achievers
in those subjects.

More males still opt for mathematics and science courses. Why do many girls
choose not to study mathematics at higher levels? Spender (1986) has declared
that: ‘Mathematics is part of the 99 percent of the world’s resources owned by
men and they guard it well’ (p.60); so much so, that ‘girls who demonstrate any
inclination or aptitude for mathematics are ‘warned off’ by the boys’ (p.59). This
is an extreme view. Jones and Smart (1995) said that it could be because girls
were failing at mathematics but more likely that they were ‘opting out of a
mathematics that is viewed as masculine’ (p.158). They offered a third option
which is that girls are ‘exercising positive choices to study subjects they value,
rather than negative choices about mathematics’ (p.164).
Mathematics for career opportunities

Bennaars (1998) described ‘schooling as a highly organised form of human resource management… whereby the best performers are selected for the job market through a complex set of examinations’ (p.58). Education has been seen (page 18) to be an economic asset and the means of social mobility. When manpower production became a major educational aim, mathematics and the sciences became an important part of the curriculum (page 20). However there was a large dropout rate in these subjects (page 20) and not enough students to fill the university places where a strong base of mathematics was needed (page 21). Mathematics is a subject where ‘relatively few students of either sex are majoring in the USA’ (Burton 1986, p.4), and ‘far too few people of either sex are becoming technologically or mathematically competent’ (Isaacson 1990, p.21).

‘Our society values mathematics. The role played by mathematics as a critical filter to further educational and career opportunities is widely recognised’ (Leder 1990, p.17). With girls choosing other subjects, it is felt that they are missing out on career opportunities. Mathematics has already been seen to be very important (page 26). Usefulness has been seen to be a criterion for participation in mathematics (pages 33-34). Students, by not continuing to study mathematics, are restricting future choices. ‘Lack of mathematical achievement will inhibit participation in many occupations and in career advancement and change’ (Fennema 1990, pp.1-2). Spender (1986) acknowledged that boys can ‘understand and readily acknowledge that mathematics is a subject which can open many career doors’ (p.58).
Bogonko (1992) strongly affirmed that 'women are more than doubly disadvantaged' as 'very few enter science, mathematics, technical and engineering courses' at university level in Kenya (pp.156-157). Girls by failing in mathematics 'have little stake in professional courses like medicine, engineering, technology and other technical disciplines' (Daily Nation, 2000d).

Research already quoted (Driver, Parry page 31 and Mittelberg and Lev-Ari page 34) has shown that girls are not necessarily disadvantaged in this area, either because they were successful in mathematics or they appreciated its usefulness. However, the female students involved did not necessarily continue to higher education and follow science-based courses.

Some research has centred on conversion courses for people with post-16 qualifications in subjects other than mathematics. Isaacson (1990) found that many women had anxieties about mathematics (p.27). Barnes and Coupland (1990) were involved in the planning and development of a short introductory course for adult students in Australia. They found 'the lack of knowledge of calculus constitutes a serious handicap for adults wanting to return to study' and that 'women form a majority of those disadvantaged in this way' (p.72).

The KCSE syllabus, compulsory for all students, includes calculus and could be said to offer equality of opportunity for the female students. However, the low scores in the KCSE mathematics' examination are inhibiting all students from furthering their education, especially in science oriented courses.
Confidence

Confidence has generally been thought of in the context of girls' lack of confidence, especially in the areas of mathematics and science. Reyes (1984) identified confidence as one of the most important affective variables. It has been established that one of the crucial indicators for female participation in mathematics in the secondary and tertiary sector in America is 'confidence/enjoyment gained from mathematical experiences' (Burton 1986, p.2). Jones and Smart (1995) wrote:

A number of issues have been identified which affect confidence: children's attitudes towards their own success in mathematics; working with contextualised problems; working with (new) technology; children's level of ability; the phenomenon of 'learned helplessness'; and teachers' styles and attitudes (p.157).

Dweck & Bush (1976) used the term "learned helplessness" to refer to the phenomenon where failure is attributed 'to factors that are believed to be uncontrollable such as lack of ability or task difficulty' (p.147). They found that girls were more readily influenced by 'failure feedback' from adults and particularly from a female adult (p.150). Jones and Smart (1995) went further:

Instead of learned helplessness we should be thinking in terms of 'taught helplessness'... As women and girls we are taught to seek reassurance, particularly in specific areas of our life, such as academia (p.161).

Girls' need for approval has already been raised (page 37) and Isaacson (1990) stressed that 'girls need to be told that they are capable of doing mathematics' (p.26). Rodgers (1990) found there was plenty of evidence 'to suggest that sometimes a word of encouragement, or the perception that a teacher or parent believed in her ability to succeed was all that was necessary to enable a girl to persevere and to push through a difficult patch' (p.31).
The suggestion is though of something more vital, a sense of powerlessness. Taylor (1986) mentions the 'well-documented patterns of female permission-seeking which reflects acceptance of less power than other groups' (p.159). This raises the whole issue of gender inequality, together with the issue of racial inequality that the researcher experienced in the London Borough of Brent (with its diversity of ethnic groupings) during the 1980s, when Ms. Taylor was advisor for equal opportunities. Driver (1980) in researching the examination results of a racial minority (West Indian children) painted a different picture when he found that the girls' success could be explained in terms of their positive ethnic qualities, which dominated their performance (p.111). Parry (1997) found similar results in Jamaica. These are contentious issues and they are more suitable to the political arena than this work.

Many girls are showing a marked lack of confidence in mathematics and one may never know all the reasons, but at what stage does this manifest itself? Shuard (1986) suggested that it is before children enter the secondary school as 'more boys than girls arrive in their new school expecting to be successful in mathematics, while many girls already feel that they are failing in the subject' (p.24). In Roberts (1984) opinion 'the first two years (of secondary school) are crucial in terms of establishing a girl's confidence in her ability to learn mathematics' (quoted in Rodgers 1990, p.34). It is certainly in the secondary years that 'failure in confidence, lack of perceived utility of mathematics, poorer attainment in mathematics compared with that in other subjects, an accumulation of social messages and boredom, take their toll' (Burton 1986, p.10).
The indications are clear and in many cases there is an opting out; girls are uninvolved in the lessons as seen by Galton, Delamont et al. (page 34). For many girls the lack of confidence is expressed in terms of difficulty. Shuard found significant differences in how difficult pupils found mathematics (page 34). Joffe and Foxman (1986) also recognised 'ratings of difficulty as the greatest source of sex differences' with 'girls indicating that they think mathematics is far more difficult than boys do' (p.42). They say that even when pupils have been successful they 'express doubt about their performance in general or attribute their success to luck. This appears to be more frequent in the case of the girls' (pp.42-43). Joffe and Foxman (1986) affirmed that girls express greater uncertainty about their mathematical performance and they tend to make more moderate assessments of their performance, whereas boys overrate their performance in mathematics (p.47). However, Mittelberg and Lev-Ari (1999) found in their research that: 'the mean scores of Arab girls evaluating their achievements as excellent in mathematics, was slightly higher than the boys' (p.82).

What can be done to remedy the situation where girls do lack confidence? As early as 1981, a BBC2 program 'A Question of Equality' looked at the experiment carried out at Stamford School where girls were taught in single-sex groupings in mathematics. Other schools were also experimenting in single-sex groupings in mathematics, and in Australia Marr and Helme (1990) wrote that in some secondary schools, 'they are experimenting with segregated classes and changes in content and delivery more suited to the learning styles of young female students' (p.81).
Burton (1990) said:

Where education systems offer the choice of either single-gender or mixed-sex organisation, research has indicated that the former appears to favour females, the latter not to prejudice males (p.2).

A report from the Office of Her Majesty’s Chief Inspector of Schools and the Equal Opportunities Commission (HMSO, 1996) asked:

Are there ways of replicating in mixed schools certain identifiable benefits of single-sex education? Should mixed schools experiment more with single-sex grouping for specific purposes, or would this be expensive and difficult to justify? (p.26).

Jones and Smart (1995) suggested that there was evidence to suggest that girls performed better in a single-sex environment (p.158). The researcher’s school in England experimented for two years, 1994-96, with single-sex groupings but did not follow through with the work (Nock 1997, pp.2-3, 110). Kruse (1996) described single-sex settings in a Danish school and found both the boys and the girls benefited. Different teaching strategies were used and different goals were set for each of the two groups (p.179).

Where there is such experimentation, planning is needed. In the researcher’s school it was a senior management decision to have single-gender teaching and no discussion or planning at the level of the teachers was deemed necessary. Taylor (1986) worked with an infant school, aiming to ‘devise and test strategies for practice which would foster good, confident girl mathematicians’ (p.156). She found that ‘the complexity of the issue was not necessarily readily recognised by teachers’ (p.156) and planned a term of discussions, followed by a year of classroom observation for the action research project.
Taylor's project did not separate the girls from the boys, but the teachers focussed on the girls and appropriate strategies were implemented to help them. It was reported that 'when faced with an unfamiliar activity, some girls who were identified as able, came to ask the teacher what to do next. They knew what to do, but needed reassurance' (pp.159-160). At the end of the time Taylor felt that questions needed to be answered, 'not least concerning how effective isolated strategies can be without the support of a general commitment to equal opportunities throughout the school' (p.162).

Teachers need to be aware of the feelings girls have towards mathematics, whether they are in a single-sex environment or not. Campbell (1996) says that students 'must experience success whenever possible' (p.33), and this is important for boys as well as girls. Smart (1995) 'hoped pupils would gain confidence with a wider range of mathematics content not normally considered part of their curriculum' (p.34). Both problem solving and investigational work can create the opportunity for stimulating discussion (Burton 1986, p.15). In Kenya, there appears to be little opportunity for such work.

Teachers need to be aware that 'an assumption of lack of confidence or anxiety about mathematics, in turn, both reinforces what is expected and can lead to a caring practice by teachers of lessening pressure on girls and offering softer options' (Burton 1986, p.7). This would again reinforce higher attainment by boys and it is performance and attainment where boys are superior, it is 'not ability' (Scott-Hodgetts 1986, p.61).
All the research has not had negative outcomes with regards to the female students. Mittelberg and Lev–Ari (1999) found that the Arab sector in Israel has succeeded in generating amongst its female students 'a high degree of perceived achievement and self-confidence in mathematics' (p.75). Unfortunately, Whitelaw et al. (2000) in England did not look at confidence as one of the affective factors in explaining differences in performances between boys and girls.

**Male domination**

Teachers treat boys and girls differently. Leder and Fennema (1990) found that 'identifiable differences in teacher treatment of males and females were found in widely divergent classrooms in different countries' (p.195). Dweck and Bush (1976) called the differences 'striking disparities' (p.148) and the consistent negative evaluation of the boys has been mentioned (page 37). This is across the curriculum and Fennema (1996) did not consider 'that differential teacher treatment of boys and girls causes gender differences in mathematics' (p.74).

Part of the reason for single-sex groupings is to place the girls in a "female-friendly" environment where they are not competing with the boys for the teacher's attention. Research has suggested that 'boys set the agenda and the pace of the work' (Jones and Smart 1995, p.159). Boys get more teacher time than do the girls and they ridicule contributions from the girls (Mahony 1985). Spender (1980) found that boys in mixed-sex classes got roughly two-thirds of the teacher attention. Stanworth (1983) noted that both girls and boys felt teachers were more concerned about boys.
Walden and Walkerdine (1986) found there were more interactions between the boys and the teacher about mathematics (p.142). It seemed to be the ability to attract the teacher's attention which differentiated the good from the poor pupils (p.139) and they found that a girl (considered good by the teacher) 'often adopted the strategy (most favoured by boys) of just calling out answers' (p.132). Binns (1986) found that the boys demanded attention immediately while the girls sat patiently with their hands up (p.153). In looking at seating arrangements Mahony (1985) found that 'over and over again, examples can be found of boys dominating the teacher's field of vision and of girls occupying marginal positions' (p.37).

These are the obvious reactions of observers in the classroom. There is another perspective. Burton (1986) wrote that the dominance by boys is not in fact an issue as girls 'dislike public confrontation and public ignominy both of which are experienced in the traditional classroom setting' (p.15). Girls do not mind the boys being asked the questions and getting the attention.

Girls do need a supportive social environment within which to learn mathematics (Burton 1986, p.2). Changes in the classroom could help the boys as well as the girls. Classrooms are needed which build pupils' independence and autonomy and 'little has so far been done to investigate what effects changes in the mathematics classroom might have on girls' and boys' attitudes to mathematics and attainment in the subject' (op. cit., p.16). Kruse (1996) found the Danish experiment of single-sex teaching beneficial for all students (p.187).
The culture of the school

The culture of the school may be said to:

Emanate from the values and beliefs of members of the organisation. These values underpin the behaviour and attitudes of individuals within schools... but they may not always be explicit (Bush 1998, p.33).

It 'is typically expressed through rituals and ceremonies which are used to support and celebrate beliefs and norms' (op. cit., p.35). It involves giving praise which 'implies recognition, celebration and reinforcement: fundamental needs of adults as well as children' (West-Burnham 1997, p.126).

The culture of the school will encompass the type of management practised. In the developed world 'the collegial approach is increasingly advocated as the most appropriate way to manage schools and colleges' (Bush 1994, p.38). The values underlying the educational practices in English schools can be identified from school mission statements and from policy documents. Included in these will be the place of equal opportunities in the school.

- Equal opportunities

Schools in the U.K. have had to work within the framework of the Sex Discrimination Act of 1975. This works towards equal opportunities for girls and boys. In the 1980s Local Education Authorities employed equal opportunity advisers to provide appropriate support to schools in the making of policy documents and bringing about effective changes. However, one still finds male domination in practice in British schools. Male 'gatekeepers' are still limiting the entrance of women to educational management (see Coleman 1994, p.192).
Mahony (1985) felt that girls were not being given adequate role models, given the position of women teachers in schools (p.23) and the researcher (Nock, 1997) found this to be the case in her school (p.115).

For those in schools in Kenya, Bennaars (1998) has the hope that ‘education aims at humanisation, at the full development of human potential’ (Bennaars 1998, p.54). This is equally applicable to students of both sexes.

- Schooling or education?

The culture of a school pervades everything about the school. It is the “hidden curriculum” with aspirations for everything pertaining to the school together with the teaching in the school and the recognised curriculum. Can the schools do more than prepare the students for examinations, which in the case of mathematics the students will fail? Certainly the schools have to look outside themselves:

For survival, the Kenyan school has a divine task to preserve and create not only culture that is distinctly Kenyan but also that which is planetary... The school has to aim for international standards...(D’Souza 1987, p.95).

In aiming for those standards Bennaars (1998) has said that ‘schooling has replaced education’ (p.22). ‘The sole criterion of educational quality, it appears, is high performance in the (national) examinations’ (op. cit., p.14). But Kenya needs hope for the future, and the educational establishments need to:

Rethink the pedagogy and seek to develop a new pedagogy: a pedagogy of hope, a pedagogy of empowerment which emphasises liberatory learning and responsible freedom (p.25).
It is recognised that:

If schools are about anything then they have to be fundamentally and obsessively concerned with providing children with the very best educational possibilities... The moral imperative is concerned with optimising the opportunities for children to achieve their full potential so that their years of compulsory education culminate in the maximum appropriate outcomes (West-Burnham 1997, p.7).

More particularly as it relates to this work there is the need to ensure that:

At the end of schooling, there should be no differences in what females and males have learned, nor should there be any gender differences in how students feel about themselves as learners of mathematics (Fennema 1990, p.5).

- **Large classes**

Results are important, and in many schools in England, mathematics classes are set by achievement. The researcher has always advocated setting and small classes if possible, but different cultures may emphasise other priorities. One country that advocates large classes and mixed ability is China. Jin and Cortazzi (1998) in their research in that country say that: ‘the dialogue about large classes needs to take cultures of learning into account’ (p.739) and so their experience may be more relevant to assessing the Kenyan situation than the researcher’s.

Jin and Cortazzi found that ‘in China, at middle school level (ages 12-18) class sizes can range from fewer than 30 to 70 or more, but are commonly 50 or 60’ (op. cit., p.739). The curriculum is managed in such a way that having larger class sizes allows each teacher to teach fewer lessons (p.741). ‘This means that more non-teaching time is available: lessons can be well prepared’ and more time is available for individual pupils (pp.741-742).
In-service training would appear to be integrated into the general structure and not “added-on” as in the English schools. Chinese teachers find time to ‘watch their colleagues teach’ (p.742). For Chinese teachers an issue of great importance is how to present knowledge and concepts, complete with good examples, in a vivid manner to enable learning’ (p.742). There is a class teaching approach. The teachers ‘treat the class as a collective’.

Chinese teachers, and often other pupils, will give extra help to those pupils who need it, thus keeping the majority within the same learning zone and maintaining high average achievement (pp.746-747).

The indigenous education in Kenya saw the learners as a group. In accepting the colonial system of education, the outcomes concentrated on the individual. In China, Jin and Cortazzi found the emphasis on learners as a group and that ‘the levels of achievement for each individual were maximised when the whole class was taught effectively’ (p.757). The emphasis in class was on listening, (p.746) so that ‘what was said by others was internalised in each individual’ (p.746). It is a teacher-centred approach which increases learner responsibility in learning how to learn’ (p.744).

- Respect for the teacher

An important part of the Chinese culture is that there is a respect for the teacher. Within the Kenyan culture this does not appear to be the case. There are considered to be too many teachers and an international research group said that Kenya had to reduce teachers by 4000 as a condition for the country to receive oversees aid (East African Standard, 2000a). Teachers do not feel secure and salary increases promised in 1997 are still not forthcoming (Daily Nation, 2000e).
- Homework

Many secondary schools in Kenya are boarding schools. The discipline of work will continue after the actual teaching with supervised homework or prep. In a day school, where many students will return to homes with no power, and it is dark between 6.30 p.m. and 7 p.m. throughout the year, expectations may be the same, but the outcomes may vary. Kelly et al. (1986) looked at the overall time students spent on homework in a group of English schools. They found that the girls were more hardworking in this respect (fewer girls spent less time, more girls spent a greater amount of time each evening on prep (p.104)). For schools placing a greater emphasis on external results homework may take a higher priority.

All of these factors serve to show the environment in which learning takes place, and in particular the learning of mathematics. It is within the schools that change will take place if there is going to be change.

The need for change

The 8-4-4 system is of psychological importance to the Kenyan government, and when the recommendations of the Koech Commission (2000) suggested changes to the 8-4-4 system it was shelved. Students will be examined in fewer subjects in the KCSE examinations, but there are to be no curriculum changes. The International Association for the Evaluation of Educational Achievement (IEA) in one of its surveys looked at three interrelated aspects relating to the curriculum:

The intended curriculum – that reflected in curriculum guides; the implemented curriculum – that actually taught; and the attained curriculum – the measure of what students have learned (from Hanna, Kungiger and Laroche 1990, p.88).
Within the Kenyan schools the intended curriculum together with the implemented curriculum are the same. The schools endeavour to complete the syllabus. It would appear that it is in the area of mathematics that the attained curriculum is most deficient. All of the literature read has been an attempt to understand this deficiency and the work of this thesis is an undertaking to clarify and possibly suggest how the situation may be amended.

The secondary school is dependent on the product of the primary schools. Shuard (1986) asserted that ‘those who are performing very well in mathematics at the age of 11 must have a very good chance of continuing to do so during the secondary years’ (p.35). ‘Past performance in mathematics is generally accepted as the best predictor of future achievement in the same area’ (Leder 1992, p.163). For Kenyan students, this would mean that those who achieved good results in the KCPE examinations would be expected to perform accordingly in the KCSE examinations. The students are failing mathematics at the end of their eight years of primary education and can thus be expected to fail at the end of their four years of secondary education. Even when the schools are getting a better intake of students, as School D for this research, the results in mathematics are still poor, though not as poor as the other schools. Teachers ‘are obliged to teach and the pupil is obliged to learn’ (see Wilson 1994, p.93) but this is not sufficient.

So there has to be change. Fullan (1992) said that: ‘the essence of educational change consists in learning new ways of thinking and doing, new skills, knowledge, attitudes etc.’ (p.122).
'Educators are important agents for change' (Fennema 1990, p.6), but the change must be seen to address priority needs with the head 'legitimating the change' (see Fullan 1992, pp. 116-117) and the decisions need to be 'genuinely collegial' (see Coleman, Middlewood and Bush 1995, p.26). The teachers recognise the need for change and the researcher hopes that in a small way this work may be an instrument for change; but in two important aspects change does not seem possible:

1. This thesis has wanted to focus on the individual, whether the individual is male or female. This suggests the need for an individual rather than a class-based pedagogy (see Murphy 1996, p.11) which has been demonstrated in pupil-centred learning strategies. This would not seem possible in the Kenyan context with its large classes and lack of resources.

2. One has to note the concern of Fennema (1996) who believes that: 'females have recognised that mathematics as currently taught and learned, restricts their lives rather than enriches them' (p.78). She suggested that we need to look at mathematics from a female perspective, that it is not the neutral subject as projected by males but that it permeates the entirety of life and so needs a female reinterpretation (op. cit., p.79). Boaler (1997) suggested that 'the negative perceptions held by underachieving girls are a product of the type of school mathematics that is currently and widely taught in the UK and the USA' (p.286). Changes may not be possible at the moment within the Kenyan context with its extensive syllabus and lack of sensitivity to anything that may be remotely termed "feminist"; but the first step, which is that of awareness, can be made.
Overview

The main focus of this work has been within the Kenyan educational system, thus an important part of the literature review centred on the development of education in Kenya. Girls have been shown to be a disadvantaged group, both with regards to the provision of schooling and within the pedagogy of difference. Mathematics has been portrayed as difficult for all students but particularly so for girls with their lack of confidence and need for re-assurance. The various aspects relating to the culture of schools have been examined, as it is within the schools that any changes will need to be implemented. The deep desires of a country where education needs to encompass a pedagogy of hope and empowerment (see page 51) have been encountered, yet the obstacles may appear insurmountable when the country has not UPE (Universal Primary Education) and does not envisage educating all its youth in the future.

The focus of this work is gender and mathematics. There appears to be a gender bias in mathematics suggesting the marginalisation of girls in this curriculum area, with research concentrating on white developed countries. Driver's research concerning West Indian students in England and Parry's work in Jamaica did not confirm existing theory. Neither did the work of Mittelberg and Lev-Ari amongst Israeli Arabs. Black Kenya, a developing nation, may provide contrasting evidence to the accepted theory and this work appears to support a theory of non-marginalisation of girls in mathematics. This also relates to girls' confidence with researchers appearing to be moving away from the concept of "learned helplessness" to an appraisal of the wider school system (Boaler, 1997).
The research questions were formulated to investigate five areas:

- teachers' attitudes,
- students' attitudes,
- confidence and enjoyment,
- failure in the KCSE examinations,
- private (English) v. state (Kenyan) education.

There is a predominance of male teachers of mathematics in Kenya. The literature suggests that that is not necessarily important as far as the girls' attitudes to mathematics are concerned. The teachers' attitudes are important and whether they are affected by the pedagogy of difference. The first research question is:

➢ Do the mathematics' teachers portray any obvious gender bias?

If mathematics is conceived to be a male domain, and the literature suggests that it is, this will be reflected in the attitudes of the students. The second question is:

➢ Are there gender differences in the ways the students see themselves in this curriculum area?

Confidence and enjoyment may or may not have any effect on the KCSE results. However, much research has been done in this area, and major gender differences have been found. The third question is:

➢ Are the boys more confident than the girls and do they enjoy the subject more?
Throughout this work the researcher has had in mind the extremely poor results in the KCSE mathematics' examinations. Are the students weak? Are the teachers poor teachers? Does the evidence suggest that the blame lies solely with the teachers or the teachers and students together or does it lie elsewhere? The fourth question is:

> Are there any evident reasons for the failure of these students in the KCSE examination?

Four of the research schools are within the Kenyan educational system. The researcher works in a private school in Kenya, where the students are considered successful at mathematics and where they expect to succeed in their examinations. The fifth question then is:

> What are the differences between the students researched in the Kenyan system of education and the students in the private school where the students will be successful in their mathematics' examinations?

Do the students' attitudes in the private school conform to research undertaken in developed countries? Are the students in the Kenyan system comparable to West Indian students in the U.K. and Jamaica and a minority group, the Arabs, in Israel.

Certainly the literature had led the researcher to believe that the research for this thesis is a vital contribution to educational research. Mathematics, gender and achievement are still of interest. Very little educational research has taken place in East Africa and it would appear that the data from this research does not always confirm the mainstream of accepted theory.
Chapter III: Methodology

Reflective practitioner

The researcher is a reflective practitioner. She is one of an increasing number of full-time teachers who are undertaking research in the classroom, thus helping to close the traditional gap that teachers perceived between theory and practice (see Woods 1988, p.102).

The researcher, on entering the classrooms of other teachers, is looking at common areas of concern, and working in partnership with these teachers who are regarded as ‘authoritative professionals rather than ‘subjects’’ (McNamara 1980, p.124). McNamara’s criticism of researchers who ‘promote their own research goals’ and ‘do no service to the teachers who have welcomed them into their classrooms’ (p.115), no longer holds with this new generation of researchers and the ‘serious professional discussion’ he advocates (p.124) ensues.

A difficulty for the reflective practitioner is that the time is not available to do the research that is possible as a full time researcher. One often works alone and this determines the whole nature of the research. A third difficulty that the researcher found was a lack of authority. She felt reliant on the good nature of head teachers and teachers. She was not a member of a research organisation that had reached an agreement with the schools for particular research purposes and she was reluctant to impose herself upon the schools. Although she could have approached the head teachers when difficulties arose, she was aware that any such move could have jeopardised a teacher’s position in the school.
Grounded theory

It would have been good to break new ground when doing research, and grounded theory 'in relying on the inquiring, analytical mind of the researcher/theorist' (Hutchinson 1988, p.124) was appealing. Grounded theory 'offers a systematic method by which to study the richness and diversity of human experience' (op. cit., p.127) of which gender plays a vital role; and as 'the data gathered and analysed are contextual' (p.125) it would have been relevant for this study.

The researcher would have liked to find new insights into understanding why students are not able to overcome seemingly insurmountable difficulties with their mathematics, particularly for the Kenyan students. She would have liked to produce the means whereby girls could have mastered this subject considered a male domain. The questions of time, working alone and the very restrictive classroom practices in Kenya, together with the possibility that perhaps there were no new insights to be found, rendered this approach not viable.

However for grounded theory, 'the notion of discovery' is fundamental (p.124), especially 'the discovery of a core variable' (p.133). For this work the "core variable" of gender was pre-determined and the researcher was therefore 'bound to focus on theory verification rather than on theory generation' (p.138). This study used 'existing theoretical and methodological literature to build the rationale for the research', rather than 'generating a theory based on behaviour patterns observed in the field' (p.137).
Ethnography

If not to find new insights, then possibly this research could have offered new perceptions into the difficulties that girls have with mathematics. Ethnography seeks to describe a given situation by closely observing how the participants interact over a prolonged period of time. It would appear to be a research method appropriate to the reflective practitioner by virtue of its 'reflective possibilities'.

'One of the strengths of recent ethnographic research on schooling is that it has taken a serious interest in pupil perspectives' (Hammersley 1981, p.169). The emphasis in this work is the students: that they are not stereotyped, that they be enabled to fulfil their potential in this core curriculum area of mathematics.

In ethnography, the social context is important. The researcher was looking at possible cultural differences in the English and Kenyan educational systems and how they would affect the teaching and learning of mathematics. However, the time factor rendered this research approach unrealistic. The researcher had to look at attitudes as portrayed in replies to questionnaires and talking to teachers rather than observe behaviour in the classroom. It was not possible to present the totality of gender effects in relation to mathematical achievement (see Uzzell 1997, p.305).

If the researcher had found, or been invited to see, any 'innovative programs in action' then she would have endeavoured to spend some time observing that teacher in order to understand and then disseminate any insights received.
Action research

Initially the researcher wished to participate in the mathematics’ department of a local Kenyan school. The head teacher and deputy felt that the girls in the mixed school needed encouragement in mathematics. It was envisaged that the researcher took two or three lessons, one day a week. She was to participate in the mathematics department and contribute to a possible gender-differentiated approach in the lessons. There were to be opportunities of working with the whole school. There would be ‘practical consequences for all the participants’ (see Uzzell 1997, p.305). Though this initiative started, it was not followed through due to difficulties within the mathematics department.

The researcher wished to make a difference. She wanted to initiate change but the nature of the Kenyan syllabus makes this very difficult. It is very intensive and non-spiralling. Once a topic has been covered there is no review. Within the British system the researcher has reviewed topics each year before starting associated topics and there is the possibility of new approaches. Also, within the British system investigative work is integrated into the schemes of work thus allowing new ways of tackling difficult topics and problems. The lack of resources would also have rendered new initiatives in the classroom unrealistic.

The large classes would not necessarily have inhibited action research as within the Chinese situation (pages 52 and 53) this would have been possible. In the Kenyan situation students are used to the teacher centred approach and the researcher found it difficult persuading the students to communicate in class.
Case study

The case study method is used when the researcher wants 'to cover contextual conditions - believing that they might be highly pertinent to the phenomenon of study' (p.13). It is an appropriate method for this study as gender differences in mathematical achievement is 'a contemporary phenomenon' within the real-life context of schools (Yin 1994, p.1).

It is the issue of gender rather than the situations of individuals that has been studied, again indicating the case study approach (see Johnson 1994, p.21). The initial study was a single-case study, with no attempt to generalise beyond the immediate school. 'Case studies are generalisable to theoretical propositions and not to populations... The investigator's goal is to expand and generalise theories' (Yin 1994, p.10). This study is a multiple-case study in an attempt to generalise gender findings in mathematical achievement in Kenyan schools and also schools embracing two different cultures.

The researcher chose to use the case study method, with, 'as unique strength, its ability to deal with a full variety of evidence - documents, artifacts, interviews, and observations' (Yin 1994, p.8). It relies on 'multiple sources of evidence' (p.13). McMillan and Schumacher (1997) wrote that; 'case study design, because of its flexibility and adaptability... provides some of the most useful methods available in educational research' (p.394). The researcher can combine qualitative and quantitative research data.
Research purposes

The "core variable" of gender has been articulated. The researcher was not aware of the intrinsic nature of gender for the Kenyan when commencing this work. She was looking for gender differences in attitudes to mathematics, not at the fundamental problem of girls being considered inferior because of their gender. A focus then became the possible marginalisation of girls and whether the evidence confirmed this, particularly in the area of mathematics.

Bassey (1992) suggested that there are two main purposes in research: 'one is to understand some aspect of education; the other is to change some aspect of education' (p.5). The KCSE examination results indicated that major changes are needed in the area of mathematics and mathematics' teaching. This researcher has endeavoured to understand the gender aspects of achievement in mathematics, in order to see whether that should be the focus for change.

It became increasingly important that the researcher could speak with authority to the head teachers and those teaching mathematics in the schools. In two of the schools the head teachers blamed first the poor teaching and second the weak students for failure in the KCSE examinations. On one occasion a district education officer (DEO) was party to the conversation with the head and concurred with the head's opinion. The head in question had taught mathematics himself. When the researcher challenged their assumption, they did actually agree with her that it was the intensive syllabus that was at least in part to blame.
In working with other teachers, ‘this research... does, potentially at least, acquaint them with consequences of their actions... of which they may not otherwise be aware’ (Hammersley 1981, p.170). Certainly teachers anticipated negative attitudes from their students, whereas the researcher met instead with positive attitudes. This may have simply been an endeavour to please on the part of the students and this will be looked at later (see page 82). The researcher had expected suggestions from the teachers in the schools for possible areas of research (see Whitelaw et al. 2000, p.91) but this was not realised.

‘The attempt in research is to refocus and clarify existing theory’ (Hutchinson 1988, p.130). It is acknowledged that gender differences in mathematics is an area of possible concern but the research has mainly been conducted in first world developed countries. The researcher has endeavoured to look more fully into the issues in a third world developing country with no Universal Primary Education. In sharing the results of the research ‘it can provide teachers with greater control over everyday events and hence increase their capacity to alter their own practice and instigate educational change if they wish to do so’ (Woods 1988, p.98).

**Areas of concern for the researcher**

Potential bias on the part of the researcher and over-familiarity with the research environment are two main areas of concern that need to be acknowledged. The question of bias is of importance. In the first school visited, the researcher inferred racial and sexual bias in a situation where in fact neither existed. The head of department was as difficult with his Kenyan, male colleagues as with her.
McNamara (1980) told the researcher to 'question the taken-for-granted assumptions within his own work' (p.119). Hutchinson's warning for grounded theory researchers 'to observe his own behaviour...' and 'become aware of his own preconceptions, values and beliefs' (p.130) is vital for all researchers. Yin (1994) cautioned the researcher not 'to be trapped by his or her own ideologies or preconceptions' and to 'be unbiased by preconceived notions, including those derived from theory' (p.56). Wolcott (1994) was more specific and declared that: 'gender bias has come to rank as high as theoretical bias as a pervasive threat to careful observation' (p.156). In focussing on gender issues, the researcher tried to avoid automatically imposing a gender interpretation on responses to the questionnaires or attitudes encountered, but was confronted with her bias on several occasions as will be mentioned later (page 75).

Familiarity with the classroom is a barrier to meaningful observation for reflective practitioners even more than for full-time researchers, especially if one is researching within one's own subject area. This researcher was herself teaching in the morning and observing classes only two or three hours later. Researchers 'must repress the overwhelming urge to evaluate rather than to observe in them' (Wolcott 1994, p.162) and this researcher sometimes wanted to get up and teach. Galton and Delamont (1985) stressed the familiarity of the classroom (pp.177-178) and said that 'classroom research is a serious business which has to be learnt' (p.176). Certainly in a team situation one has the opportunity to exchange ideas and evaluate observations more objectively. This was to some extent possible when the researcher had time to talk with the teachers.
Methodology

Research design:

The research design details four areas of development:

1. the research questions,
2. the relevant data,
3. data collection and
4. data analysis (Yin 1994, p.20).

The researcher is indebted to the work of Yin, and integrated 'his five components of a research design: a study's questions, its propositions, its units of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings' (p.20) into the areas of development. The propositions and units of analysis were examined when considering the relevant data; the logic and criteria for interpreting the findings were examined under the section on data analysis.

There are also four aspects that Yin emphasised for the case study investigator to 'maximise in the quality of any design: (a) construct validity, (b) internal validity, (c) external validity and (d) reliability at the data collection stage' (p.18). These were considered separately.

- Research questions

The research questions developed during the time of research. The original study (Nock, 1997) had taken place in the U.K. and the emphasis of this study was to have been to investigate whether the same gender differences were apparent in Kenya. The researcher wanted to investigate the ways students learned mathematics, their attitudes to the subject and their achievement.
An aim of the research was to have been to investigate good practice, to establish a good predictor of mathematical achievement for teachers and to find ways of ensuring equality of opportunity for girls. It was also hoped to explore ways of giving students a ‘value-added’ education.

The researcher did not have the opportunity to observe lessons as she had wished: though access to mathematics classes had been requested initially, this request was mainly ignored. The availability of time also inhibited classroom observation. The “chalk and talk” teaching, single lessons and almost total lack of resources meant that there appeared to be no opportunity of examining ways of enhancing the classroom teaching during this period of research.

The lack of access to results meant that the researcher could not do the quantitative analysis that she had hoped to do. Also, she could not examine the possibility of a ‘value-added’ education in this important curriculum area.

The research questions that developed within the Kenyan context are those detailed in the previous two sections, and are the following:

- Do the mathematics’ teachers portray any obvious gender bias?
- Are there gender differences in the ways the students see themselves in this curriculum area?
- Are the boys more confident than the girls and do they enjoy the subject more?
Are there any evident reasons for the failure of these students in the KCSE examination?

What are the differences between the students researched in the Kenyan system of education and the students in the private school where the students will be successful in their mathematics’ examinations?

- Relevant data

"Do the mathematics’ teachers portray any obvious gender bias?"

It has been proposed that mathematics is considered a male domain and that both parents and teachers influence students into similar thinking. Moreover, in the Kenyan context, it has been suggested that girls are denied equal opportunities as a pedagogy of difference exists. It was not possible to gain information from the Kenyan parents. Many of the parents of the local day students had not received any secondary education and did not speak English: some only spoke their mother tongue and not Kiswahili. For boarders and the students in the researchers’ own school, access to all the parents was not realistic, as even getting information for the school from these parents was often problematic. Thus the teachers were the units of analysis for this part of the study.

Data from teachers was by means of a first questionnaire. It had been hoped that there would be interviews with the teachers. In schools B and C, the researcher managed to spend some time with all the mathematics teachers, whereas in schools A and D she did not even get to meet all the mathematics’ teachers. So a second questionnaire was compiled and sent into the schools.
Methodology

There was some lesson observation in school B, so the researcher was able look at
the possible dominance of boys in the classroom with the teacher and students
being the units of analysis. Seating was not examined, as the whole question of
male dominance in the classroom did not appear to have the same significance in
the Kenyan classroom that it has in a child-centred classroom in the West.

“Are there gender differences in the ways the students see themselves in this
curriculum area?”

As a consequence of mathematics not being considered an area of female
achievement, it has been proposed that girls underrate their ability in this area. It
has also been proposed that girls base success on hard work and luck, whereas
boys consider achievement to be based on their ability in mathematics. The
research group was the students in the different schools. The data was in the form
of completed questionnaires. The possibility of interviews was rejected due to
time and the unreliability of the information gained (if the interviewees wished
only to please the interviewer).

“Are the boys more confident than the girls and do they enjoy the subject more?”

Most of the literature would suggest that it is the case that boys are more
confident and they enjoy mathematics more than the girls. Again, the units of
analysis were the students, and their responses to the questionnaires gave the
relevant data to respond to this question. Reasons for enjoying or disliking
mathematics were also investigated to see if these generated gender differences in
the student responses.
"Are there any evident reasons for the failure of these students in the KCSE examination?"

The researcher herself had proposed that it is the overloaded KCSE syllabus that contributes to the failure of the students in their national examinations. She analysed the syllabus and the 1999 KCSE mathematics papers, and categorised each question according to the status it would be given within the U.K. examination system. Teachers and students were also the units of analysis, as their attitudes would also have suggested whether failure was inevitable.

"What are the differences between the students researched in the Kenyan system of education and the students in the private school where the students will be successful in their mathematics' examinations?"

The researcher had expected that students under an apparent regime of failure would be discouraged and portray negative characteristics with regards to their mathematics lessons. This was expected to contrast with those students who would be successful in their external examinations. The units of analysis were the students in all the five schools and the data used was again the responses to the questionnaires.

- Data collection

Data collection was more difficult than envisaged. The intention had been to disseminate questionnaires, interview teachers and students and undertake lesson observation. Initially the two schools A and B appeared very co-operative and all the original teachers' questionnaires were returned.
Methodology

The heads of department undertook to ensure completion of the students' questionnaires. Some lesson observation took place in school B but only 56% of the student questionnaires were returned from that school completed. In school C, questionnaires were disseminated and returned without the researcher ever visiting the school, whilst in school D the head teacher undertook to have the questionnaires completed. Despite frequent visits to the schools the researcher was not successful in arranging to meet mathematics teachers, gain examination results or arrange interviews. A second teachers' questionnaire was distributed to the schools and only one was returned. Wishing to persist, this questionnaire was redistributed to the schools and despite frequent visits not all were returned. Thus most of the data was in the form of answers to questions and statements on the questionnaires even though initially schools had agreed to lesson observation, interviews and providing the researcher with examination data.

- Data analysis

Yin (1994) tells us that 'every case study investigator must work hard to report all evidence fairly' (p.10). This is not always possible and Galton and Delamont (1985) described how they took the quantitative data 'as the findings' and 'other material was used to illuminate or flesh out these results' (p.172). The researcher responded in a similar manner. Thus the talks with the teachers and head teachers and the classroom observation were used to illustrate certain aspects of the questionnaire responses or inferences from the literature. Throughout this work the researcher has also been aware of reports in the press, which have highlighted aspects of this work.
Methodology

'The researcher looks for patterns' (Hutchinson 1988, p.135) and the data was considered in this way. The researcher looked for patterns of behaviour that possibly distinguished the girls from the boys, together with patterns of behaviour as students progressed from year to year through the school. As this has not been a longitudinal study care had to be taken to avoid drawing conclusions that necessarily imply that certain behaviours manifest themselves as students progress through the school. An enthusiastic cohort may well continue enthusiastic through the four years of secondary school though this may be unlikely.

The interpretation of the findings was based on the literature that was used to build the rationale for the research. The literature relating to Kenyan education, West Indian and Arab students illuminated those areas where the present research appeared to contradict previous research in the area of gender and mathematics.

The researcher hopes that there is a clear logic behind the research questions. Looming large was the fact that these students fail in mathematics and that the head teachers and teachers considered that the girls were more likely to perform badly than the boys. The starting point was the teachers and whether they portrayed any gender bias? Even if the teachers were not biased, the students themselves may have fixed attitudes that were gender related and attitudes relating to confidence and enjoyment in the area of mathematics were highlighted.

When the attitudes of the teachers and students did not point to failure, an answer had to be found elsewhere and for the researcher this was the syllabus.
Teaching within the English system (in a Kenyan private school), the researcher was aware that the majority of her students would not be successful in the Kenyan system, hence the need to examine the mathematics examinations and also to compare attitudes between students in the two systems. The researcher believes that the responses to the research questions may forward the education of both girls and boys in Kenya in this crucial educational area.

- **Construct validity**

How objective has this study been? The researcher sought to be objective by researching in different schools and letting the maths’ teachers in the schools review the findings. The possibility of bias has already been raised, and it is possible for teachers in a specialised subject area such as mathematics to have a common bias. Thus a teacher from another curriculum area (in the researcher’s own school) was called on to assess the work for possible bias, also a local pastor who had taught Kiswahili at school A. Yin (1994) wrote that a test of the validity ‘is the degree to which you are open to contrary findings’ (p.59). The researcher found during the course of the study that, despite affirmation to the contrary she had anticipated certain results in expecting more negative results from the girls.

It had been hoped that triangulation through the use of different data-gathering methods (questionnaires, interviews and observation), together with the parents, teachers and students responses would address ‘the potential problems of construct validity’ (op. cit., p.92). As this was not possible, the extension of the study to include different schools was expected to validate the research.
Methodology

- **Internal validity**

  The question of bias may also affect the internal validity of the study. The data has been collected and analysed on the basis of gender. Therefore there is the inherent danger that seeming prejudicial inferences may be made where there were no gender issues. The researcher has endeavoured to look at other possibilities whenever possible (see Yin 1994, p.35).

- **External validity**

  Looking at a variety of schools there is a greater possibility of the 'study's findings being generalisable beyond the immediate case study' (op. cit., p.35). The similarities between the responses of students from these different schools enhance the findings in this study and the overall evidence or lack of evidence of gender differences is more compelling.

- **Reliability**

  This is a multiple-case with the research being replicated. It is hoped that it is thus reliable. The aim of the study has been explicitly to develop research that can be easily reproduced in other schools.

**Choice of schools**

The researcher has chosen to look within the educational establishments where she was working or had easy access. The original study (Nock, 1997) was a single-case study in the Grant-Maintained school where she worked in England. It proved to be a pilot study for this later work.
Throughout her first year in Kenya, (September 1998-9) various exercises were undertaken in her school to determine possible routes for this study as further literature was also being read. During that first year, she also visited on several occasions a local school and did some teaching there. A Kenyan teacher in her school introduced her to the school. This school was later dropped from the study. A person on the administrative staff of her own school then introduced her to another secondary school (School A). She managed two visits to this school. This then developed and with another school (School B) formed the basis of the multiple-case study. School B became integrated in the study through meeting one of its mathematics' teachers at a local church.

Schools A and B are in the same town and can be considered representative of the local mixed secondary schools, though not of Kenyan schools. One is a day school, the other a day and boarding school. Schools C and D were included when the researcher found she could not gain sufficient evidence to triangulate her work. These two schools would present evidence in situations where boys were not dominating girls in the mathematics' classroom. A teacher from School C (with a very small number of boys) offered to take the questionnaires into the school. School D was contacted directly as it was an all girls’ boarding school with good results in the KCSE examinations.

The difference in intake between the local schools and the researcher’s own school is immense. Students (School E) come from the neighbouring countries of Tanzania and Uganda as well as from Kenya.
As one of the elite schools in East Africa, many students will continue their education in England, the United States or South Africa. Students from the local schools may not get a place in higher education, even with good results in the KCSE, and for some the fees would render further education impossible. Even completing secondary education will not guarantee them employment. So the students are from completely different backgrounds.

Major tasks

‘Two of the major tasks in collecting data include gaining access to key organisations or interviewees and providing for unanticipated events, including changes in the availability of interviewees’ (Yin 1994, pp.68-69). The schools chosen were welcoming to the researcher. Actual access was not easy, as the researcher worked full-time and the schools in Kenya had similar holidays. Fortunately, the researcher had a half-day to compensate for Saturday morning teaching and this was utilised for school visits.

In the first local school visited the attitude of the head of the mathematics department rendered a continuation of the study in the school futile. It would have been possible to go to the deputy head or head, but that would have imposed unwelcome constraints in the mathematics’ department. The teacher, who had originally welcomed the researcher to the mathematics’ department in school A and permitted lesson observation, moved to a different area and was not part of the later research.
Methodology

The researcher expected to approach the head teachers as the 'gatekeepers of data', to consent to the research in their schools (see Johnson 1994, p.76). In the very first school and school B, this was the route taken. In school A, introductions were through the deputy head and the researcher later met with the head teacher, similarly in school C.

The data was not of a controversial nature, and a copy of the relevant research data, analysis and conclusions were given to the mathematics departments in the schools with a summary to the head teachers. The data collected did not pose the same ethical problems faced by Denscombe and Aubrook (1992, p.118) in their research into teenage drug taking. There were though clearly problem areas arising with the teachers of particular classes: in school A in the mathematics department and in school D in other curricular areas. As the data has been processed by year group and not by class the controversial data was less obvious and the researcher considered that discerning schools would have been aware of the difficulties with these teachers.

Can one analyse the background of these students? Denscombe and Aubrook (1992), when analysing the DISPRIN and DART projects, found that 'questions which concern others (such as their parents) are not considered legitimate' (p.119). The researcher decided not to try. Within the Kenyan context, any information concerning 'parental work status and education' may be misleading as many have not had the opportunities to continue their education, and conversely, others may have inappropriate employment or be unemployed.
Methodology

Research tools:

- **Documentary analysis**

In English schools a first undertaking would be a documentary analysis. School mission statements, the equal opportunities and staff development policies as well as the school development plan would be examined. There is not the documentation in the Kenyan schools, neither has it been deemed necessary for the private school to produce such material. The Kenyan mathematics' syllabus, the IGCSE and Additional Mathematics syllabi and past KCSE papers were the only documentary evidence used.

- **Interviews**

The researcher hoped to conduct interviews to confirm what she experienced in the school. ‘Observing, by itself, is never enough because it begs misinterpretation’ (Hutchinson 1988, p.125). Interviews, generally informal in nature, augment formal observations and serve to clarify the meanings participants attribute to a given situation (p.130). Formal interviews were not held though it could be argued that the talks, which ensued in the schools, did constitute informal interviews.

Originally the researcher had hoped to conduct interviews with some of the students ‘to check on their responses to the questionnaire and to delve deeper into some of the issues raised by the questionnaire’ (see Denscombe and Aubrook 1992, p.114). Interviews would have been problematic due to the language and also the Kenyans’ desire to please.
Methodology

Though English is the medium of instruction in the secondary schools, it may be the students' third language. The accent of the researcher, the manner of talking, the implicit meanings of words and phrases, all would provide obstacles to communication with people who are not used to speaking with native English speakers.

- Questionnaires

There were two questionnaires for the teachers (Appendix A and Appendix B) and one for students (Appendix C) and adapted for school D (Appendix D). In three of the schools a copy of the students' questionnaire was submitted prior to dissemination. It was hoped that the teachers might change some of the questions and make suggestions before the questionnaire was formalised, but no changes were suggested. Whether this was by courtesy (automatically agree with the researcher) or conviction (the questions asked were suitable) the researcher is not certain. It has been suggested that the researcher's experience would have been respected and hence no changes were offered even though they were requested.

The first teachers' questionnaire was formulated from the literature with a view to eliciting possible gender bias from the respondents. As the questions were gender driven, this questionnaire was not given to the teachers in the all girls' school. When the responses to the students' questionnaires had been collated and there seemed no possibility of interviews with the teachers, the second questionnaire was constructed. One of the aims was to see how the teachers themselves viewed the mathematics' lessons, another to obtain insights from these mathematics' teachers that could be passed on to others.
The students' questionnaire was adapted from Barnes, Plaister and Thomas (1984). In its original form, one box was given and the respondent had to tick if he/she agreed with the statement, put a cross if he/she disagreed, or leave blank:

[] 6. I usually feel confident about maths tests

Collating the data from the original questionnaires in the U.K. the researcher felt that more clarification was needed and decided to give three labelled boxes:

<table>
<thead>
<tr>
<th>I usually feel confident about maths tests</th>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
</table>

Five boxes had been suggested to avoid too many answers in the middle. Rather, the researcher expected many responses to be in the middle and she intended to focus on the extremes. However, the students did not just take the middle option.

Though doubts have been expressed about interviewing the students there were no fears about their understanding written English and their ability to answer the questionnaires. In working through all the questionnaires the researcher was impressed with the manner in which they had been answered. There was no indication that the task had been rushed or completed involuntarily.

Denscombe and Aubrook (1992) postulated that students could 'give answers geared to what they believe are the correct answers or the answers the researchers might want to find' (p.122). Each question for this research appeared to have been judged on its own merit. The questions on confidence and enjoyment were separated on the original questionnaires. For school D (the amended questionnaire) the questions were placed together. A response for one question did not determine the response for the subsequent question in any of the schools.
Denscombe and Aubrook queried whether or not their own questionnaires on drug-use were 'in fact completed voluntarily and with the willing co-operation of pupils' (p.113). They were working in schools and knew 'there exists a form of institutional coercion in the sense that the context is inscribed by differential power relations' (p.128). They felt that 'in the school context, young people are something of a captive audience... The vital point is not that pupils are free to say no but that they feel free to say no' (pp.129-130). The researcher followed Denscombe and Aubrook's initiative, inviting participants to add 'any comments they felt were appropriate concerning the questionnaire' (p.115).

- **Classroom observation**

The classroom observation was for three purposes:

1. so that the students were able to accept the researcher,
2. to look at seating plans to determine male domination in the room and
3. to determine the nature of exchanges between the teachers and students.

The purpose was not to analyse different teaching or learning styles. This was outside the remit for the study, though they may affect students' achievement. In school B, the researcher visited many of the classes and either talked with the students with their class teacher present, was left with the students for a lesson to become acquainted with them or was introduced to the class and subsequently observed the lesson. In the other schools it has already been stated that the researcher was not able to properly fulfil this part of her study though she concluded that very little had been lost by this lack of lesson observation.
Methodology

Limitations of the study

The difficulties that have arisen during the period of research have been highlighted. The researcher being a full-time teacher working alone has clearly limited the research possibilities. Access to parents and co-operation of teachers in the schools limited the data available. The inadequacy of the lesson observations and the lack of teacher and student interviews may be considered to nullify what the researcher has to say. However, she still feels that there is enough evidence to validate the study.

There is research data from five very different schools. The four Kenyan schools differ greatly in the percentage of female students in the schools. The fifth school is very different in its educational environment. There is research data from teachers and students, together with some lesson observation and some talks with head teachers and teachers.

The evidence for each school has been considered separately with cross-analysis being undertaken in the section: Themes and further analysis before the overall conclusions have been reached.
Chapter IV: Evidence

Schools differ very much from one another in a single country. When one compares schools in two countries the difference is enormous, especially when the countries are categorised as first world and third world countries. The lack of facilities and the large number of students in the classes appear to characterise the local Kenyan schools. However, in England and in Kenya, in the private and in the state systems, mathematics is considered a central part of the curriculum. Talking with mathematics' teachers one realises that the same difficulties pertain in both the countries. Mathematics is found to be difficult by the students and it is considered to be a male domain.

It is important that the researcher's experience in the first Kenyan school is noted though no data for the research was collected. She was warmly welcomed into the school by the head teacher and the deputy head teacher, particularly because she was a woman. They felt that she could encourage all the girls in the school. However, from the first meeting with the head of the mathematics department there were difficulties. It was suggested that she would not be able to teach despite having a mathematics' degree and considerable experience. A form 2 class was chosen and the researcher suggested that she teach the topic least liked by the class teacher. Graphical work was chosen but, in the third session with the class, the researcher discovered that the class teacher had been going back over the work that the researcher had covered. Another class had not been organised, the researcher had still not met other members of the department and on one occasion she turned up to find classes doing exams and could not teach.
It was not a workable situation so she wrote letters of apology to the school and did not return in a research capacity. As already intimated (page 66) she also implied racial bias as well as sexual bias in this encounter with the head of department and was subsequently shown that these were prejudiced views. The experience in this school was important in that it:

1. Indicated that the head teacher and others in a school considered girls to be having difficulties with mathematics and they wanted to improve the situation.

2. Showed that a topic (graph work) considered by schools in England to be difficult was difficult in Kenya.

3. Gave the researcher some experience of teaching in a Kenyan school.

In the researchers' limited experience there did not appear to be much individual participation in lessons, teaching was from the blackboard, with students working through the textbooks. The researcher in this first school had great difficulties encouraging students to even say a word and there was little opportunity for praise. Often responses in the classes she observed were group responses.

The researcher has had to adapt to the Kenyan culture when observing classes and in collecting her evidence. The four local schools, from whom data was collected, were different with their own specific culture, whilst at the same time being similar. The overall emphasis on the importance of the examination results was a constant in each school. The best students in each subject in each year are recognised at a special prize-giving assembly. Teachers with the best results in the school are also recognised and they are given a monetary reward.
Teachers feel insecure in their posts as mentioned (page 53). This was highlighted for the researcher when a teacher in school A was given a letter of transfer on Friday 11th February and expected to take up a position in another area on Monday 14th February. The result was low self-esteem amongst the teachers that will be reflected in their work and affect the ethos of the school. The researcher did not gain an impression of respect for the teaching staff from the head teachers (page 65).

In Kenyan schools most heads and deputies are male, together with the teaching staff. Male 'gatekeepers' are in evidence and there are very few role models for girls. Only in school A were there large numbers of female teachers yet in the mathematics department only two out of the eight teachers were female. School D, an all-girls secondary boarding school, had a female head teacher but only one of the six mathematics' teachers was female. Whilst the impact of male teachers may be great, the literature has shown that this does not adversely affect the mathematics' teaching with regard to girls.

The evidence collected has been in the form of two teachers' questionnaires and one students' questionnaire. The teachers in school E only completed the first questionnaire and the teachers in school D only completed the second questionnaire. The students in school D completed an amended questionnaire. The evidence has been presented separately for each school giving first some background information for the school.
The evidence for schools A, B and C has been presented in the same manner: an overview of the first teachers’ questionnaire followed (for school A) by an overview of the students’ questionnaire. The responses from the students’ questionnaires were considered under the headings: the importance of mathematics, perceived ability, basic attitudes (liking or disliking mathematics), confidence, mathematics as a male domain and male domination. There follows a section on other issues before the responses to the second teachers’ questionnaire have been presented.

As the evidence from schools A, B and C suggested that students considered mathematics to be very important, the researcher did not ask about this in school D. Instead she investigated whether maths was one of the best or worst subjects, and why students may find mathematics easy or difficult. Perceived ability, basic attitudes and confidence were then covered before looking at other issues and the responses to the teachers’ questionnaire.

The results from the KCSE mock examination (2000) were made available to the researcher in school C. For school E the examination results for June 2000 have been presented. The presentation of evidence for school E has been similar to that of the first three schools. The second teachers’ questionnaire was not given to the teachers in this school as the resources available in this school, together with setting after the first year and small classes would help the Kenyan teachers. A comparison of the IGCSE and Kenyan syllabi is found in Appendix H.
School A:

Background information

School A was one of the first schools that the researcher visited. The head of department was not available at the time, and another teacher (since transferred from the school) undertook the introductions to the school. This involved talking generally about the school, mathematics and gender difficulties in mathematics. On a second visit the researcher visited a class and was invited to comment upon the teaching. She was invited to teach later but this was not possible at the time.

During the collection of data, the head of mathematics was happy to ensure that the first teachers' questionnaires and the students' questionnaires were completed but little more. Duplicates of the second teachers' questionnaire were taken into the school and after four visits, six out of the eight were completed and returned. This may have been more to do with the individual teachers and the Kenyan culture. However, on several occasions the researcher tried to gain information about exam results but it never materialised.

51% of the teaching staff are female. In the mathematics department two of the eight teachers are female, the head of department is male. The student body consists of six hundred and eighty-two students of whom 30.8% are female:

<table>
<thead>
<tr>
<th></th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>53</td>
<td>54</td>
<td>52</td>
<td>51</td>
<td>210</td>
</tr>
<tr>
<td>Boys</td>
<td>111</td>
<td>119</td>
<td>120</td>
<td>122</td>
<td>472</td>
</tr>
</tbody>
</table>

Table 2: Students in the school

There are four classes in each year, the class sizes ranging from 41 to 44.
Evidence

The head of the mathematics department undertook the distribution of the questionnaires with 543 returned (80%). Eight could not be used at all, as the respondent had not designated male or female. Five girls and six boys had not given their form: they were included in the totals but not in a form group.

First teacher's questionnaire

The emphasis of this questionnaire was gender differences. The researcher was looking for evidence of possible gender bias on behalf of the teaching staff. Opinions held by the teachers will influence their ways of relating to students, especially the female students.

The eight mathematics' teachers together with the headmaster who had taught mathematics completed the first questionnaire. There was no response to some statements and when more than one response was given no response was taken. The responses (Appendix E) show that no one considered mathematics to be a male domain. No teacher felt that students needed a teacher of the same gender. Nobody judged that boys received more teacher time or that they always blamed failure on lack of effort. Generally it was believed that boys are confident and that girls fear being asked questions together with being influenced by failure feedback. One male member of staff suggested that it was more important for boys to do well. Only in geometry was it felt that girls are not as good as the boys. The two female teachers agreed that “mathematics is never a male domain” and that “it is never more important for boys to do well”. They both deemed boys “hardly ever to be better than girls at statistics”.

Page 90
Students' questionnaire

The percentage return for the girls was 80% the boys 78%. The highest returns were from the girls in form 1 (98%) and form 4 (94%) and the boys in form 1 (92%). The results were collated by gender.

75% of the students responded that mathematics was important and needed for employment. Very few of the students considered themselves to be good at mathematics, though the percentage of boys was two and a half times that of the girls. Almost twice the percentage of girls perceived themselves to be weak.

The majority of students stated that they enjoyed maths and felt confident about the subject at least some of the time, over a third all the time. Over half of all students replied that they could understand the purpose of the mathematics taught and enjoyed solving problems though they considered that you had to be clever to do maths. 74% of the girls and 63% of the boys felt that luck was a factor if they did well. More than three-quarters said that they found the work easy if they worked carefully. Over 80% spent a half-hour or more on homework, boys being more likely to spend longer. Boys said they understood new ideas more quickly, appeared more confident about tests and considered themselves less nervous when looking at problems or when asked questions in class. There were small differences in responses about getting most of their work right and accepting that students could enjoy mathematics. 69% of the boys stated that boys always wanted to beat girls at maths, whereas 39% of the girls perceived this to be the case.
Evidence

The importance of mathematics

Mathematics is a compulsory subject and many of the students questioned this even though they did consider it to be a very important subject. The highest percentage of students who disagreed was the girls in form 2, but they all stated that mathematics was of some importance. Both girls and boys considered mathematics important for gaining employment, but they were more sceptical in form 4, the last year of secondary schooling.

<table>
<thead>
<tr>
<th>Girls</th>
<th>Very</th>
<th>Not very</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 1</td>
<td>85%</td>
<td>13%</td>
<td>2%</td>
</tr>
<tr>
<td>Form 2</td>
<td>68%</td>
<td>32%</td>
<td>77%</td>
</tr>
<tr>
<td>Form 3</td>
<td>83%</td>
<td>17%</td>
<td>73%</td>
</tr>
<tr>
<td>Form 4</td>
<td>77%</td>
<td>17%</td>
<td>77%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Boys</th>
<th>Very</th>
<th>Not very</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 1</td>
<td>86%</td>
<td>14%</td>
<td>2%</td>
</tr>
<tr>
<td>Form 2</td>
<td>77%</td>
<td>20%</td>
<td>2%</td>
</tr>
<tr>
<td>Form 3</td>
<td>73%</td>
<td>23%</td>
<td>4%</td>
</tr>
<tr>
<td>Form 4</td>
<td>77%</td>
<td>21%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 3: How important do you feel maths is?

<table>
<thead>
<tr>
<th>Girls</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 1</td>
<td>88%</td>
<td>12%</td>
<td>79%</td>
</tr>
<tr>
<td>Form 2</td>
<td>79%</td>
<td>21%</td>
<td>82%</td>
</tr>
<tr>
<td>Form 3</td>
<td>94%</td>
<td>6%</td>
<td>83%</td>
</tr>
<tr>
<td>Form 4</td>
<td>67%</td>
<td>28%</td>
<td>64%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Boys</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 1</td>
<td>79%</td>
<td>21%</td>
<td>82%</td>
</tr>
<tr>
<td>Form 2</td>
<td>83%</td>
<td>16%</td>
<td>83%</td>
</tr>
<tr>
<td>Form 3</td>
<td>83%</td>
<td>15%</td>
<td>83%</td>
</tr>
<tr>
<td>Form 4</td>
<td>64%</td>
<td>34%</td>
<td>64%</td>
</tr>
</tbody>
</table>

Table 4: Will knowing maths help get you a job?

They were not asked whether they would choose to continue to study mathematics at a higher level. Many girls gave mathematics as an important subject for a future career as a reason for liking mathematics especially in form 1

<table>
<thead>
<tr>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 1</td>
<td>Form 2</td>
</tr>
<tr>
<td>29%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Table 5: Percentages of students specifying that maths was important for their career as a reason for liking mathematics
Perceived ability

The students were asked: How good are you at maths?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th></th>
<th>Boys</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
<td>Average</td>
<td>Weak</td>
<td>Good</td>
<td>Average</td>
<td>Weak</td>
</tr>
<tr>
<td>Form 1</td>
<td>13%</td>
<td>85%</td>
<td>2%</td>
<td>25%</td>
<td>73%</td>
<td>3%</td>
</tr>
<tr>
<td>Form 2</td>
<td>61%</td>
<td>39%</td>
<td>9%</td>
<td>76%</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Form 3</td>
<td>57%</td>
<td>43%</td>
<td>8%</td>
<td>57%</td>
<td>36%</td>
<td></td>
</tr>
<tr>
<td>Form 4</td>
<td>4%</td>
<td>31%</td>
<td>65%</td>
<td>7%</td>
<td>59%</td>
<td>35%</td>
</tr>
</tbody>
</table>

Table 6: How good are you at maths?

A greater percentage of boys and girls considered themselves to be weak at mathematics in each successive year in the school, and except in form 1, the percentages were much higher for the girls. The students in form 1 have not arrived at the school thinking that they were no good at mathematics. One cannot say whether the increased percentages of students perceiving themselves to be weak are a result of the teaching they have had in the secondary school.

Mathematics is a subject where many find intrinsic difficulties and students may be discouraged if they feel you have to be clever in order to do well.

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th></th>
<th>Boys</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Form 1</td>
<td>71%</td>
<td>19%</td>
<td>10%</td>
<td>67%</td>
<td>21%</td>
<td>13%</td>
</tr>
<tr>
<td>Form 2</td>
<td>50%</td>
<td>11%</td>
<td>39%</td>
<td>46%</td>
<td>12%</td>
<td>42%</td>
</tr>
<tr>
<td>Form 3</td>
<td>60%</td>
<td>23%</td>
<td>17%</td>
<td>50%</td>
<td>13%</td>
<td>37%</td>
</tr>
<tr>
<td>Form 4</td>
<td>26%</td>
<td>21%</td>
<td>53%</td>
<td>36%</td>
<td>18%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Table 7: Do you have to be clever to do maths?

The majority of students opted for one of the extremes. 50% and over of the girls in forms 1, 2 and 3 stated yes, whilst it was in forms 1 and 3 that 50% and over of the boys replied in the affirmative. The percentages were much lower in form 4.
Basic attitudes

Students were asked whether they liked or disliked maths and to give their reasons. 58% of all the girls responding to the questionnaire liked maths, as did 70% of all the boys. It was only in form 1 that the girls really liked maths (85%). Their responses for liking/disliking mathematics were studied and then grouped into four categories:

1. Utility of the subject. Mathematics will help one to get a job, it helps in other subjects and it enables one to sort out problems, makes one think faster and helps one to relax. Some of those disliking maths felt it would not be useful.

2. Ability in the subject. Students may be naturally good or find the subject easy. Others find they are hopeless, they are slow learners and it is very difficult. They forget quickly and are unlucky in exams. One student had never achieved more than 30% in mathematics’ tests.

3. Attributes of the subject. Students may find mathematics interesting and enjoyable. For some it is playing with numbers or just learning and following formulae. It does not involve much reading or cramming for exams. It is possible to gain 100% in exams. For others it is not interesting, there is too much calculating, the formulae are difficult, they cannot solve the problems and it gives them a headache. Too much time has to be spent on the subject, and for some, however much effort they put into the subject they are still not successful (get good marks).

4. Other factors. Having a good teacher influenced some students. For other students the same teacher was regarded as poor. Too much homework, lack of adequate books and peer pressure caused some to dislike mathematics.
Evidence

Like

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Utility</td>
<td>Ability</td>
<td>Att.</td>
<td>Other</td>
</tr>
<tr>
<td>Form 1</td>
<td>48%</td>
<td>31%</td>
<td>17%</td>
<td>4%</td>
</tr>
<tr>
<td>Form 2</td>
<td>21%</td>
<td>21%</td>
<td>50%</td>
<td>7%</td>
</tr>
<tr>
<td>Form 3</td>
<td>25%</td>
<td>40%</td>
<td>35%</td>
<td>4%</td>
</tr>
<tr>
<td>Form 4</td>
<td>50%</td>
<td>20%</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 8: Reasons for liking mathematics

The girls in forms 2, 3 and 4 were more likely than the boys to say that they liked mathematics because of their ability in the subject and many students realised the utility of mathematics for their future careers (see Table 5, page 92).

Dislike

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not useful</td>
<td>Lack of ability</td>
<td>Att.</td>
<td>Other</td>
</tr>
<tr>
<td>Form 1</td>
<td>63%</td>
<td>38%</td>
<td>71%</td>
<td>21%</td>
</tr>
<tr>
<td>Form 2</td>
<td>15%</td>
<td>15%</td>
<td>69%</td>
<td>7%</td>
</tr>
<tr>
<td>Form 3</td>
<td>50%</td>
<td>27%</td>
<td>23%</td>
<td>14%</td>
</tr>
<tr>
<td>Form 4</td>
<td>66%</td>
<td>14%</td>
<td>20%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 9: Reasons for disliking mathematics

Some boys in the higher forms considered mathematics, especially algebra, to be of no use. Form 2, boys and girls, considered poor teaching to be their main reason for disliking mathematics. Only 68% of the questionnaires were returned from form 2, but still, sizeable numbers in the year expressed dissatisfaction with the teaching.

Is mathematics a subject to be enjoyed?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>Maybe</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Form 1</td>
<td>65%</td>
<td>18%</td>
<td>18%</td>
<td>64%</td>
</tr>
<tr>
<td>Form 2</td>
<td>50%</td>
<td>18%</td>
<td>32%</td>
<td>51%</td>
</tr>
<tr>
<td>Form 3</td>
<td>46%</td>
<td>14%</td>
<td>40%</td>
<td>51%</td>
</tr>
<tr>
<td>Form 4</td>
<td>35%</td>
<td>9%</td>
<td>57%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Table 10: Can you understand how students can enjoy maths?
Increasingly, students responded that they couldn’t understand how students could enjoy maths. They appear to be entering the secondary school anticipating enjoyment, though in form 4 a different picture is portrayed. Whether or not they themselves actually enjoy maths is a different matter. When asked whether they themselves enjoy maths, the following responses ensued:

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
<td>Always</td>
</tr>
<tr>
<td>Form 1</td>
<td>56%</td>
<td>40%</td>
<td>4%</td>
<td>66%</td>
</tr>
<tr>
<td>Form 2</td>
<td>48%</td>
<td>44%</td>
<td>7%</td>
<td>58%</td>
</tr>
<tr>
<td>Form 3</td>
<td>26%</td>
<td>66%</td>
<td>9%</td>
<td>43%</td>
</tr>
<tr>
<td>Form 4</td>
<td>22%</td>
<td>67%</td>
<td>11%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Table 11: Do you enjoy maths?

The boys’ responses suggested that they enjoyed mathematics more than the girls in each year group did; but with all students the apparent enjoyment of mathematics decreased as they continued through the school. Liking maths and enjoying maths were not synonymous for these students.

Problem solving was one of the reasons given for disliking mathematics.

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
<td>Always</td>
</tr>
<tr>
<td>Form 1</td>
<td>83%</td>
<td>17%</td>
<td></td>
<td>68%</td>
</tr>
<tr>
<td>Form 2</td>
<td>52%</td>
<td>48%</td>
<td></td>
<td>66%</td>
</tr>
<tr>
<td>Form 3</td>
<td>54%</td>
<td>40%</td>
<td>6%</td>
<td>49%</td>
</tr>
<tr>
<td>Form 4</td>
<td>35%</td>
<td>52%</td>
<td>13%</td>
<td>44%</td>
</tr>
</tbody>
</table>

Table 12: Do you enjoy solving maths’ problems?

Students stating enjoyment of solving maths’ problems decreased through the years of schooling, though the girls in form 3 did not conform to the trend. Form 4 girls were more emphatic in stating that they never enjoyed solving them.
Evidence

Confidence

Girls generally are considered to be less confident than boys are at mathematics. The teachers' responses certainly suggested boys were more confident, though one of the male teachers judged that girls never lacked confidence. Two of the other male teachers felt that girls were always influenced by failure feedback whilst the female teachers were divided. Students themselves were asked: Do you generally feel confident about maths? It was the girls in form 1 who appeared to be the most confident about mathematics, more so than the boys. The boys appeared to have retained their confidence into form 2.

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Form 1</td>
<td>57%</td>
<td>43%</td>
</tr>
<tr>
<td>Form 2</td>
<td>37%</td>
<td>59%</td>
</tr>
<tr>
<td>Form 3</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td>Form 4</td>
<td>21%</td>
<td>69%</td>
</tr>
</tbody>
</table>

Table 13: Do you generally feel confident about maths?

Students considered themselves less confident as they progressed through school, the largest percentage of students expressing no confidence were the form 4 girls.

They were also asked: Do you feel confident about maths' tests?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Form 1</td>
<td>47%</td>
<td>45%</td>
</tr>
<tr>
<td>Form 2</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Form 3</td>
<td>24%</td>
<td>55%</td>
</tr>
<tr>
<td>Form 4</td>
<td>17%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Table 14: Do you feel confident about maths' tests?

Boys said they were more confident about maths' tests, and in form 4, 42% of the girls were never confident which bodes ill for the KCSE examinations.
Perhaps it is just a part of mathematics that increases the nervousness in girls.

They were asked: Do you feel nervous when you look at a maths’ problem?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Form 1</td>
<td>8%</td>
<td>73%</td>
</tr>
<tr>
<td>Form 2</td>
<td>21%</td>
<td>61%</td>
</tr>
<tr>
<td>Form 3</td>
<td>14%</td>
<td>74%</td>
</tr>
<tr>
<td>Form 4</td>
<td>25%</td>
<td>67%</td>
</tr>
</tbody>
</table>

Table 15: Do you feel nervous when you look at a maths’ problem?

The girls in form 1 responded that they were generally confident about maths’ tests and they were the least nervous when looking at maths’ problems. Large percentages of boys said that they never felt nervous when looking at problems.

There are considered to be basic gender differences in students’ attitudes to success. The teachers did not consider that the boys blamed failure on lack of effort and only two of them, one male and one female, thought that girls always attributed failure to lack of ability. The students were asked: Are you lucky when you do well in a maths test?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Form 1</td>
<td>83%</td>
<td>12%</td>
</tr>
<tr>
<td>Form 2</td>
<td>68%</td>
<td>21%</td>
</tr>
<tr>
<td>Form 3</td>
<td>66%</td>
<td>20%</td>
</tr>
<tr>
<td>Form 4</td>
<td>75%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Table 16: Are you lucky when you do well in a maths test?

Boys appear less likely to ascribe success in a maths’ test to luck than the girls, even though luck still accounts for over 60% of the responses. The girls’ responses in form 1 suggested they were most likely to assign success to luck.
Evidence

Students had a question whereby they had to ✓ statements that they considered appropriate when they did well/badly in maths. Luck was not an option for doing well, though being unlucky was a possible reason for doing badly.

If I do well in maths it is usually because:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F. 1</td>
<td>F. 2</td>
</tr>
<tr>
<td>I'm naturally good</td>
<td>19%</td>
<td>4%</td>
</tr>
<tr>
<td>I have a good teacher</td>
<td>73%</td>
<td>44%</td>
</tr>
<tr>
<td>I work very hard</td>
<td>87%</td>
<td>85%</td>
</tr>
<tr>
<td>The work is very easy</td>
<td>10%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Table 17: Reasons for doing well in maths

Most students attributed doing well to working hard. Except for the form 2 girls, more than half the students appeared to recognise the contribution of the teacher if they did well. Form 4 girls seemed to feel that if they did well the work must be easy. Form 1 girls were as optimistic as the boys about being naturally good at maths if they did well; the girls in form 2 appear to have a lower self-esteem.

If I do badly in maths it is usually because:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F. 1</td>
<td>F. 2</td>
</tr>
<tr>
<td>I'm always hopeless</td>
<td>18%</td>
<td>26%</td>
</tr>
<tr>
<td>I didn't try hard enough</td>
<td>78%</td>
<td>70%</td>
</tr>
<tr>
<td>I was unlucky</td>
<td>24%</td>
<td>19%</td>
</tr>
<tr>
<td>The work is too hard</td>
<td>33%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Table 18: Reasons for doing badly in maths

The girls were more likely to put down failure to bad luck than the boys. Except for form 2 boys and form 4 girls, over 70% of all the other students contributed failure to a lack of hard work. With the exception of form 2, the responses showed that the girls were more likely to suggest that they were hopeless.
Mathematics as a male domain and male domination

The literature suggests that mathematics is a male domain. The teachers at this school did not agree, though the teaching resources (or lack of them) may well inhibit them in trying to teach mathematics in a manner that is equally accessible to the girls. Is it more important for boys to do well? One male respondent said, "Yes". Perhaps this is the realistic answer rather than the idealistic one. Students will experience mathematics differently if it is male-oriented. Boys will grasp new ideas more quickly, will feel they are more successful in the subject (get most of their work correct) and see the point of what they are doing.

They were asked: Do you understand new ideas quickly?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Form 1</td>
<td>38%</td>
<td>56%</td>
<td>6%</td>
<td>47%</td>
</tr>
<tr>
<td>Form 2</td>
<td>21%</td>
<td>61%</td>
<td>18%</td>
<td>42%</td>
</tr>
<tr>
<td>Form 3</td>
<td>34%</td>
<td>51%</td>
<td>14%</td>
<td>38%</td>
</tr>
<tr>
<td>Form 4</td>
<td>15%</td>
<td>51%</td>
<td>34%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Table 19: Do you understand new ideas quickly?

Boys said they were more likely to understand new ideas quickly, though all students felt it became more difficult to understand new ideas quickly as they progressed: the responses from the girls in form 3 not conforming to this trend.

They were also asked: Do you get most of your maths right?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
<td>Always</td>
</tr>
<tr>
<td>Form 1</td>
<td>29%</td>
<td>71%</td>
<td>Never</td>
<td>28%</td>
</tr>
<tr>
<td>Form 2</td>
<td>4%</td>
<td>82%</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>Form 3</td>
<td>3%</td>
<td>86%</td>
<td>11%</td>
<td>10%</td>
</tr>
<tr>
<td>Form 4</td>
<td>3%</td>
<td>79%</td>
<td>21%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table 20: Do you get most of your maths right?
As students advanced through the secondary school, they were less likely to have the impression that they were getting most of their maths correct. Except for form 1, the girls did not appear to be experiencing success on a regular basis. Mathematics may be difficult for students if they do not understand the relevance of the work they are doing. It was only boys who gave as their reason for disliking maths that it would be of no use, especially the algebra. The students were asked: Do you see the point of most of the maths you do?

<table>
<thead>
<tr>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Form 1</td>
<td>77%</td>
</tr>
<tr>
<td>Form 2</td>
<td>43%</td>
</tr>
<tr>
<td>Form 3</td>
<td>57%</td>
</tr>
<tr>
<td>Form 4</td>
<td>44%</td>
</tr>
</tbody>
</table>

Table 21: Do you see the point of most of the maths that you do?

The boys' answers did not imply that they were more likely to see the significance of the mathematics they learnt, but the work was less relevant for form 4 students.

Boys are considered to be more dominant in the classroom, increasing girls' nervousness in the subject, especially when the girls are asked a question. Only one male teacher stated that girls always fear being asked questions. Otherwise opinions were equally divided. The students' responses were:

<table>
<thead>
<tr>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
</tr>
<tr>
<td>Form 1</td>
<td>17%</td>
</tr>
<tr>
<td>Form 2</td>
<td>18%</td>
</tr>
<tr>
<td>Form 3</td>
<td>14%</td>
</tr>
<tr>
<td>Form 4</td>
<td>25%</td>
</tr>
</tbody>
</table>

Table 22: Do you feel nervous if you are asked a question in class?
Between a quarter and a third of the girls said they never felt nervous when asked a question in class, whereas more than a third, but less than a half of the boys replied similarly. Double the percentage of boys in form 3 to those in other forms declared themselves to be nervous.

How dominant did the teachers consider the boys to be? The teachers were very divided on whether the boys set the pace of the work, though the female teachers were inclined to say that they did. Generally the teachers did not feel that the boys got more of their time. The students were not asked whether they felt that the teachers gave the boys more time, though some (mostly girls) declared that the teachers did not spend enough time answering questions of the less able.

In a male dominated classroom the boys would want to be superior. The students were asked the question: Do boys like to beat girls at maths?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Form 1</td>
<td>15%</td>
<td>60%</td>
<td>25%</td>
</tr>
<tr>
<td>Form 2</td>
<td>25%</td>
<td>54%</td>
<td>21%</td>
</tr>
<tr>
<td>Form 3</td>
<td>60%</td>
<td>34%</td>
<td>6%</td>
</tr>
<tr>
<td>Form 4</td>
<td>60%</td>
<td>27%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Table 23: Do boys like to beat girls at maths?

This was the only question that was queried by the students. Some of the girls did not like the question but they did not suggest any alternative. The majority of boys felt that boys always liked to beat the girls. However, this attitude was not conveyed to the girls, especially those in forms 1 and 2, who were definitely not of this opinion.
Other issues

The teachers felt that boys were better at number than girls, but that the girls were generally better at algebra. They deemed the boys better at geometry than the girls, but there was no consensus amongst the teachers about students’ ability in statistics. Students were asked to state their favourite topic. Favourite does not necessarily imply the topic where they are most successful, but would appear to be indicative of some ability in that area. Some gave more than one and all the topics were taken; but by giving one topic, they were necessarily omitting others. Others failed to respond.

<table>
<thead>
<tr>
<th>Topic</th>
<th>F. 1 girls</th>
<th>F. 2 girls</th>
<th>F. 3 girls</th>
<th>F. 4 girls</th>
<th>F. 1 boys</th>
<th>F. 2 boys</th>
<th>F. 3 boys</th>
<th>F. 4 boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Num.</td>
<td>38%</td>
<td>50%</td>
<td>26%</td>
<td>27%</td>
<td>39%</td>
<td>39%</td>
<td>22%</td>
<td>14%</td>
</tr>
<tr>
<td>Comm. Arith</td>
<td>4%</td>
<td>3%</td>
<td>5%</td>
<td>3%</td>
<td>5%</td>
<td>3%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Alg.</td>
<td>28%</td>
<td>36%</td>
<td>51%</td>
<td>63%</td>
<td>17%</td>
<td>35%</td>
<td>53%</td>
<td>66%</td>
</tr>
<tr>
<td>Graph</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Geom</td>
<td>28%</td>
<td>32%</td>
<td>11%</td>
<td>29%</td>
<td>45%</td>
<td>40%</td>
<td>8%</td>
<td>26%</td>
</tr>
<tr>
<td>Stats</td>
<td>4%</td>
<td>14%</td>
<td>15%</td>
<td>10%</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>7%</td>
<td>2%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form 1 Topics</td>
<td>2%</td>
<td>2%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not alg</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not surds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not vectors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>6%</td>
<td>2%</td>
<td></td>
<td>1%</td>
<td></td>
<td>1%</td>
<td></td>
<td>1%</td>
</tr>
</tbody>
</table>

Table 24: Favourite topics in maths

A greater percentage of the boys said they preferred geometry in the first two forms, and in forms 2, 3 and 4 a greater percentage of the girls said they preferred number. Students appeared to increasingly like algebra as they progressed through the school.
The teachers considered the girls to be neater than the boys, but were divided on how much homework the students were doing. Students were given extra work (homework) to do in mathematics every day. This became more onerous for them in the higher forms as they were expected to do more work in all areas of the curriculum and this was cited by some as a reason for disliking mathematics. Students were not asked about the totality of time spent on homework, but: How long do you tend to spend on maths homework (prep)?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than ½ hour</td>
<td>About ½ hour</td>
<td>More than ½ hour</td>
</tr>
<tr>
<td>Form 1</td>
<td>12%</td>
<td>60%</td>
<td>29%</td>
</tr>
<tr>
<td>Form 2</td>
<td>21%</td>
<td>39%</td>
<td>39%</td>
</tr>
<tr>
<td>Form 3</td>
<td>17%</td>
<td>71%</td>
<td>11%</td>
</tr>
<tr>
<td>Form 4</td>
<td>21%</td>
<td>35%</td>
<td>44%</td>
</tr>
</tbody>
</table>

Table 25: How long do you tend to spend on maths homework?

Throughout the school, just over 40% of the boys said they spent more than ½ hour doing prep. The girls only reached the same level in form 4. The majority of the girls in form 3 appeared not to spend extra time on their mathematics' work.

Girls were generally not considered to learn better than the boys though one female teacher felt that they always did learn better; nor more hardworking with the same female teacher stating that they were always more hardworking. Some of the men teachers responded never to both questions. Students were asked whether they found maths easy if they worked carefully and except for form 4 girls the response was generally Yes.
The greatest differences are between form 4 girls and boys, and form 2 girls and boys. In form 2 the percentage of girls is greater than that of the boys who stated that they found maths easy if they worked carefully but it appears to be much more difficult for the girls in form 4. Just over half the girls said they found maths to be easy if they worked carefully, but this is less than in the other classes.

Did the students enjoy answering the questionnaire?

The students were very responsive to the question about enjoying the questionnaire. They welcomed the opportunity of sharing their opinions, being able to be open about their problems with mathematics and “say how they really feel”. Many stated that it helped to show them the importance of mathematics and enabled them to recognise areas of weakness. They were encouraged and pleased to know that someone cared. Several hoped that the researcher could in fact help them. A few did not enjoy answering the questionnaire as they couldn’t see any reason to it and one boy thought that they were silly questions.
Nearly all the students had questions to ask of the researcher: Why is mathematics so important and does one really need to study it? Why is maths so difficult, particularly for girls? Why do students fail when they try so hard and how can they improve in mathematics? They wanted to know how they could like or enjoy mathematics and how they could become more confident. A few students queried the lack of textbooks in the school.

Second teachers' questionnaire

Five male teachers and one female teacher returned this second questionnaire, which was aimed at getting further insights into the attitudes of the teachers. The head of department did not give this questionnaire to the headmaster. There was a range of answers.

Do we tend to emphasise the difficulties of mathematics? One teacher replied “Yes”, two replied “Sometimes” and three (including the female teacher) replied “No”. Do we tell students that they have to be clever to do mathematics? The same numbers resulted, but except for the female teacher they did not give the same response to the two questions. Do we sometimes tell our students that they are no good at mathematics? No answer from the female teacher, one teacher admitted “Yes”, the others responded “No”. Three teachers expected enjoyment in their lessons, two sometimes and again there was no response from the female teacher. Five teachers, including the female teacher, considered that they instilled confidence in the subject, one that he did sometimes.
There were several suggestions about removing students’ apprehensions about mathematics:

1. Demystifying the subject, using simple language and teaching from the known to the unknown. Reviewing the teaching materials.
2. Seeking to raise motivation, ensuring each student participates in the lesson and equipping them with problem solving skills.
4. Having student discussion groups and forming a mathematics counselling group.

All the teachers considered that the teaching should be relevant to the students but none of them were aware of cross-curricular activities.

Four teachers, including the female teacher, felt that there was too large an ability range in the classes, one said “Sometimes” and felt that one should restrict the entry of students and one said “No”. Those who said “Yes” made several suggestions:

1. Forming discussion groups.
2. Grouping students in class according to ability and giving group work.
3. Letting the brighter students help the weak ones.
4. Giving extra work to the brilliant ones and remedial work to the weak ones.
5. Giving more emphasis to all areas and motivating all students.
Evidence

Several suggestions were given about encouraging students though one teacher has been trying to no avail.

1. Motivating them, helping them with any questions and rewarding them.
2. Appreciating them and giving verbal reinforcement when they answer questions.
3. Giving them exercises that are relevant and within their capability.
4. Supplying them with adequate learning materials and relevant textbooks.
5. Giving many but simple tests and setting exams with questions that are varied to cater for all students.

The following suggestions were offered in order to help students who find it difficult to understand new ideas:

1. Giving the pupils extra remedial work/lessons.
2. Drilling.
3. Encouraging them to ask questions.
4. Encouraging them to work even harder

The main obstacles to being more successful were given as:

1. Inadequate teaching materials.
2. Too big a syllabus.
3. Negative attitudes of students, poor morale, lack of motivation and students’ inability to tackle the subject.
Some of the male teachers gave the following insights that they have found useful in teaching mathematics:

1. Being patient and encouraging the students.
2. Having the interests of the students at heart and letting them know this.
3. Using charts and models to interest the students.
4. Encouraging student involvement in solving problems on the blackboard.
5. Not to use severe punishment.

Several of the teachers were able to give examples of students who had given them encouragement in their teaching. These were students who were appreciative, some of whom had been successful, others who had not been successful in their mathematics' examinations. Some students had continued mathematics at university, even to masters' level. Sometimes it was the female students who were not very knowledgeable but kept coming for help or weak students who were still willing to learn and have moved from low to average levels in problem solving. Students who were interested: asking for help outside lessons or finding extra problems that they wanted help in solving or students who read ahead and were able to challenge the teacher.

So the teachers, as well as encouraging and motivating the students, have in turn been encouraged and motivated.
Evidence

School B:

Background information

The researcher had had conversations about teaching and mathematics with one of
the mathematics' teachers before she visited this school. The first visit was very
formal, being introduced to the head teacher and other teachers in the staff room.
The head teacher together with the two mathematics' teachers appeared happy to
co-operate with the research. The school is a boarding and a day school with
eighteen teachers, five of whom are female, and two mathematics' teachers who
are both male. The student body consists of five hundred and forty-four students,
56.3% girls:

<table>
<thead>
<tr>
<th></th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>101</td>
<td>77</td>
<td>62</td>
<td>66</td>
<td>306</td>
</tr>
<tr>
<td>Boys</td>
<td>54</td>
<td>68</td>
<td>57</td>
<td>59</td>
<td>238</td>
</tr>
</tbody>
</table>

Table 28: Students in the school

The classes are all mixed with the largest class size being 66 students. In the 1999
KCSE examination the mean score was 3.299 (D) the mean maths score was
1.291 (E). 56% of the girls and 58% of the boys' questionnaires were returned, so
the evidence is based on just over half of the school population.

It was considered important that as many of the students as possible had met the
researcher before the students completed the questionnaires. Two half days were
spent visiting the classes. Seven out of ten classes were visited. On some
occasions there were three way discussions between the researcher, the class
teacher and the students in the class, at times the researcher was introduced and
the lesson continued, at other times the researcher was left with the class.
Evidence

Class visits

The classes were large. Three or four students sat at a desk for two, five students at a desk for three people. There were not enough textbooks, no posters, just “chalk and talk”. The class tended to work together and as a group often gave the required answers. The teachers were not seen to ‘pick’ on a student and so there was not the problem of girls’ reluctance to be asked or to answer questions. When students gave answers they were allowed to make mistakes; when they worked through questions on the board they were encouraged to the final solution in both the teachers’ classes.

The researcher found considerable interaction between the students and the two teachers in this school. In the two form 1 classes visited there were some girls who were very enthusiastic and there were many volunteers (girls and boys) to work on the board. In the form 2 class visited girls were considered to be among the best students. Whereas some of the form 1 students considered 80% a result to aim for in tests, form 2 students said they could not envisage getting much higher than 50% in tests. In one of the form 3 classes visited a group of girls were in the dominant position in the class, sitting together in the centre at the front. The girls readily communicated with the researcher who was left with this class. In one of the form 4 classes visited boys were in the dominant positions, as a group at the front in the centre of the class. The best student was considered to be a boy who was also good at physics. In this class there was more communication with the boys. As these students were approaching the KCSE examinations the difficulty of the mathematics’ examination was broached.
First teachers’ questionnaire

The responses are given in Appendix F. Both teachers considered that the boys sometimes set the pace of work but that they never got more teacher time. The teachers felt that the boys were always confident and that the girls were likely to lack confidence. They felt that possibly the girls needed female teachers. The overall impressions gained by talking to the two teachers were that older students influenced the younger students and that the older students often said that maths is difficult: it’s too hard. It was also considered that mathematics is a subject where one fails: the exam is there to make you fail and this resulted in a lack of confidence in the subject.

Students’ responses:

The importance of mathematics

Mathematics is a compulsory subject and the students appeared to recognise that it is important: 86% of the boys and the girls stated that it was very important. 86% of the girls and 90% of the boys said that: “Yes, knowing maths will help get you a job”.

Perceived ability

How did the students perceive their ability in mathematics?

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th></th>
<th>Boys</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
<td>Average</td>
<td>Weak</td>
<td>Good</td>
</tr>
<tr>
<td>Form 1</td>
<td>9%</td>
<td>91%</td>
<td>28%</td>
<td>61%</td>
</tr>
<tr>
<td>Form 2</td>
<td>88%</td>
<td>13%</td>
<td>6%</td>
<td>88%</td>
</tr>
<tr>
<td>Form 3</td>
<td>63%</td>
<td>37%</td>
<td>5%</td>
<td>64%</td>
</tr>
<tr>
<td>Form 4</td>
<td>61%</td>
<td>39%</td>
<td>5%</td>
<td>61%</td>
</tr>
</tbody>
</table>

Table 29: How good are you at maths?
The only girls who considered themselves to be good at mathematics were in form 1 and none of the girls in that form perceived themselves to be weak. Certainly amongst this cohort of students, the girls gave indications of a positive attitude. 11% of form 1 boys considered themselves to be weak.

Both mathematics teachers thought that the students arrived at the school believing that mathematics was difficult and that students in the higher forms reinforced this attitude amongst the students, especially the girls. This does not appear to have been the case.

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Form 1</td>
<td>35%</td>
<td>15%</td>
</tr>
<tr>
<td>Form 2</td>
<td>94%</td>
<td>6%</td>
</tr>
<tr>
<td>Form 3</td>
<td>73%</td>
<td>19%</td>
</tr>
<tr>
<td>Form 4</td>
<td>63%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Table 30: Do you have to be clever to do maths?

The boys were less inclined than the girls to think that you had to be clever to do maths. There was a big increase in the second year of students thinking you had to be clever, this decreasing in form 3 and form 4 though one of the teachers admitted that teachers tell students that they have to be clever to do mathematics.

Basic attitudes

94% of girls in form 1 said they liked mathematics, 82% of the boys. In form 2, all students returning questionnaires professed to like mathematics. This was the year where most students considered that you had to be clever to do mathematics.
Evidence

The percentages then dropped, except for the boys in form 4 where 82% of the boys liked mathematics. Overall, 76% of the girls and 78% of the boys who completed the questionnaires said they liked the subject.

The one teacher who returned the second teachers’ questionnaire expected enjoyment in his lessons. Only three girls declared that they never enjoyed the subject, together with six of the boys. 41% of the girls and 39% of the boys stated that they always enjoyed mathematics and 59% of the girls and 55% of the boys always enjoyed solving maths problems.

Confidence

Are the boys more confident with regards to mathematics and mathematics’ tests? The teachers believed them to be. Are the girls more likely to feel nervous when they look at maths’ problems or when they are asked a question in class? The researcher was not aware of this when she visited the classes. The one teacher who returned the second teachers’ questionnaire considered that he instilled confidence in the subject and it would appear that both the teachers are instilling confidence. 30% of the boys together with 29% of the girls who replied said they generally felt confident about maths. Only one girl and four boys said that they never felt confident. 44% of the boys and 41% of the girls said they always felt confident about mathematics’ tests with eleven girls and eleven boys (4%) saying they never felt confident when it came to tests. The students were confident with regards to maths’ tests but they still felt that luck had a part when they did well in a maths’ test: 67% of the girls and 69% of the boys declared they were lucky when they did well. Twenty-three girls and twenty-two boys (8%) said, “No”.

Page 114
What reasons did the students give when they performed well or badly?

If I do well in maths it is usually because:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>I'm naturally good</td>
<td>F. 1</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>F. 2</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>F. 3</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>F. 4</td>
<td>4%</td>
</tr>
<tr>
<td>I have a good teacher</td>
<td>82%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>41%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>58%</td>
<td>12%</td>
</tr>
<tr>
<td>I work very hard</td>
<td>100%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>94%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>91%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>98%</td>
<td>12%</td>
</tr>
<tr>
<td>The work is very easy</td>
<td>12%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Table 31: Reasons for doing well in maths

Both teachers had considered that the girls were generally more hardworking than the boys were. Most students, boys as well as girls, attributed doing well to working hard so the boys themselves think that they are hardworking. Except for the forms 2 and 4 girls, more than half the students who completed questionnaires recognised the contribution of the teacher to their performing well. In form 2 an equal percentage of boys and girls regarded themselves as naturally good if they did well, otherwise the percentages of boys in each year who considered themselves as naturally good exceeded those of the girls.

If I do badly in maths it is usually because:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>I'm always hopeless</td>
<td>F. 1</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>F. 2</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>F. 3</td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td>F. 4</td>
<td>51%</td>
</tr>
<tr>
<td>I didn't try hard enough</td>
<td>79%</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>94%</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td>61%</td>
<td>21%</td>
</tr>
<tr>
<td></td>
<td>70%</td>
<td>25%</td>
</tr>
<tr>
<td>I was unlucky</td>
<td>26%</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>6%</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>17%</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>9%</td>
<td>7%</td>
</tr>
<tr>
<td>The work is too hard</td>
<td>41%</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>34%</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>25%</td>
<td>34%</td>
</tr>
</tbody>
</table>

Table 32: Reasons for doing badly in maths

The teacher responding to the second questionnaire considered that the difficulties of mathematics tended to be emphasised but that students were never told that they were no good.
Evidence

From the responses, the boys were more likely to perceive themselves to be hopeless in forms 1 and 2, the girls in forms 3 and 4. More than half the girls in form 4 replied that they felt they were hopeless when they did badly. The KCSE results are likely then to demoralise them as far as mathematics is concerned. The greater percentages of boys attributing doing badly to being unlucky were in forms 1 and 3, not throughout the school. The percentages of boys considering the work to be too hard were greater than those of the girls, except in form 1. The lowest percentage of students who deemed themselves not to have worked hard enough were the girls in form 3.

Mathematics as a male domain and male domination

The teachers do not appear to be alienating the girls in the mathematics' lessons but this does not gainsay the fact that mathematics is considered to be a male domain. One of the teachers had replied that sometimes it is a male domain. If that is the case then boys will understand new ideas more quickly, they will be more likely to get most of their maths right, and the curriculum will be more relevant to them. The boys will see the point of most of the maths that they do rather than the girls. In none of these instances is that seen to be true in school B.

<table>
<thead>
<tr>
<th></th>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes/Always</td>
<td>No / Never</td>
</tr>
<tr>
<td>Do you understand new ideas quickly?</td>
<td>25%</td>
<td>8%</td>
</tr>
<tr>
<td>Do you get most of your maths right?</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>Do you see the point of most of the maths you do?</td>
<td>54%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table 33: Responses that could be indicative of mathematics being a male domain
The percentages were slightly higher for the boys’ responses at the negative extreme, which counters the fact that in this school mathematics is a male domain. Only in the situation of getting work correct were there a higher percentage of boys at the positive extreme. Otherwise, a greater percentage of girls said they understood new ideas quickly and saw the relevance of the work that they were doing.

**Other issues**

The teachers both stated that the girls did more homework than the boys did. Overall, 33% of the girls and 30% of the boys claimed to do more than half an hour whilst 11% of the girls and 17% of the boys admitted to doing less than half an hour; so it would appear than the girls did do more homework than the boys. The girls were generally considered to be more hardworking: did this then facilitate the learning of mathematics? 84% of the girls responding to the questionnaire said they found maths easy if they worked carefully together with 82% of the boys, so there was not a great difference.

The girls would not appear to be marginalised in the mathematics’ lessons in this school, but is there the element of competition? Do the boys like to beat the girls at maths? 29% of the girls declared always, 38% never. Amongst the boys, 82% of the boys said, “Always”, 4% said, “Never”. Whatever the boys said, they did not communicate this desire for superiority to most of the girls. The students’ questionnaire responses indicated a positive attitude to mathematics: the majority who answered the questionnaire enjoyed the opportunity of sharing their thoughts.
Second teachers’ questionnaire

Only one of the two teachers returned this questionnaire. Some of his responses have been integrated into the previous pages. The obstacles given by him to being more successful were students’ lack of interest, lack of resources especially practical objects for demonstration purposes and large classes. Possibly this research generated some enthusiasm amongst the students, as the researcher did not get any impression of a lack of interest on the part of the students.

This teacher’s suggestions for removing students’ apprehensions about mathematics were to encourage teacher-student discussions; to encourage students, with the teacher’s guidance, to answer questions on the board and to avoid the lecture method in class. He considered that the teaching should be relevant to the students. His suggestions for encouraging students were to make them understand that mathematics can be easy, to endeavour to interest them more in the subject and to give them more homework.

He stated that the ability range was too large in the classes and to overcome this he said that the teacher needed to identify each student’s ability and take more time explaining to the less able in the class. He felt that more time and individual help should be given to those students who find it difficult to understand new ideas together with more examples and exercises. His insights were to relate mathematics’ problems to real life and to help students work through questions on the board (this was observed by the researcher). Students who performed well encouraged him as did those who became more active in answering questions.
School C:

Background information

In school C the numbers were dropping and the KCSE examination results were very poor. In an effort to improve the situation it was decided that the school would become an all-girls' school and numbers increased in form 1. In forms 3 and 4 some of the students had achieved only 250 out of 700 marks in the KCPE examination, though the best student in form 4, a male, had achieved 512 out of 700 marks but his parents could not afford the fees for other schools. He is one of the day students of whom there are just under fifty. In the present forms 1 and 2 the mean mark was 350 out of the 700 marks.

The school has one full time mathematics' teacher and two teachers who teach mathematics and physics. The three teachers are male. The student body consists of two hundred and eighty-four students of whom thirteen are boys (4.6%):

<table>
<thead>
<tr>
<th></th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>68</td>
<td>52</td>
<td>71</td>
<td>80</td>
<td>271</td>
</tr>
<tr>
<td>Boys</td>
<td>6</td>
<td>7</td>
<td></td>
<td></td>
<td>13</td>
</tr>
</tbody>
</table>

Table 34: Students in the school

There are two classes in each year group, the largest class size being 49 in form 4. Forms 1 and 2 have classes of equal sizes. In the 1999 KCSE examination the mean score for the school was 2.96 on a 12-point scale (25%), the mean maths score was 1.26 (10%).

A teacher friend in the science department offered to take the questionnaires into the school and distribute them. 84% of the students' questionnaires were returned completed: 228/271 for the girls and 9/13 for the boys.
Later the researcher went into the school and introduced herself to the head teacher. On another occasion the researcher requested to see the head of the mathematics department and spend some time in the school. She received an extremely warm welcome and the teachers impressed the researcher. The head of department, together with the two teachers who take some of the mathematics classes, gave two hours of their time and spoke openly about the difficulties facing them in the department. They requested that the researcher take some classes in the next academic year starting in January.

Mock KCSE results, 2000

Eighty-four students completed the district mock examinations. The subject taking first position was Kiswahili 5.226 (C) on a twelve-point scale. The last three subjects were maths 2.000 (D-), biology 1.707 (D-) and chemistry 1.464 (E).

The maths results were:

<table>
<thead>
<tr>
<th>Grade</th>
<th>B-</th>
<th>C+</th>
<th>C</th>
<th>C-</th>
<th>D+</th>
<th>D</th>
<th>D-</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td></td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>16</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 35: Mock KCSE mathematics’ results

Comparing the mathematics’ result with the overall average mock mark across all subjects only one student (a girl) gained a higher grade for her mathematics.

<table>
<thead>
<tr>
<th>Difference in grades</th>
<th>+1</th>
<th>0</th>
<th>-1</th>
<th>-2</th>
<th>-3</th>
<th>-4</th>
<th>-5</th>
<th>-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>1</td>
<td>13</td>
<td>17</td>
<td>21</td>
<td>17</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Boys</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 36: Difference between the maths grades and the overall mock mark

This difference in grades, if it occurs in the actual KCSE examinations, will disadvantage those students who wish to continue with their studies at university.
First teachers' questionnaire

Only one of the original teachers' questionnaires was returned and as there were so few boys in the school the researcher decided not to pursue the matter. The one teacher stated categorically that neither boys nor girls needed teachers of their own sex and that it is not more important for boys to do well. Always, he considered that girls were influenced by failure feedback, that they lacked confidence and that they feared being asked questions. He considered that girls were always neater than boys are and that girls did more homework than the boys did. Sometimes the girls were more hardworking and learnt better than the boys.

He did not consider that mathematics was a male domain though he felt that boys sometimes got more teacher time. He stated that boys were hardly ever confident and they sometimes blamed failure on lack of effort, the girls sometimes attributing failure to lack of ability. He responded that boys were considered to be better than girls at geometry, sometimes at algebra and hardly ever at number and statistics.

Students' responses:

The importance of mathematics

67% of the students said that mathematics was very important, only four of the students felt that it was not at all important. Some of the girls who considered that mathematics was not very important still stated that knowing maths will definitely help them get a job. A greater percentage of the girls said that knowing maths will definitely get you a job. The boys were more reluctant, 44% stating maybe.
Perceived ability

21% of the girls and 22% of the boys considered themselves to be weak at mathematics, 5% of the girls together with 22% of the boys considering themselves good. 38% of the girls and 33% of the boys had responded that you did not have to be clever to do mathematics; 36% of the girls and 22% of the boys still felt that you did have to be clever.

Basic attitudes

Did the students actually like or dislike mathematics?

<table>
<thead>
<tr>
<th></th>
<th>Like</th>
<th>Dislike</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Form 1</td>
<td>Form 2</td>
</tr>
<tr>
<td>Girls</td>
<td>85%</td>
<td>63%</td>
</tr>
<tr>
<td>Boys</td>
<td>33%</td>
<td>67%</td>
</tr>
</tbody>
</table>

Table 37: Percentages showing students liking/disliking maths

The girls in form 1 appeared very positive about mathematics. Six girls in form 1 and another six in form 2 liked maths but they found it difficult or couldn’t always understand it. One girl in form 1 generally disliked it but liked it when she could understand. Eight girls who liked maths in form 3 also gave reasons for disliking the subject; two disliked it because they found it hard yet they still enjoyed it sometimes. One girl in form 4 liked maths but didn’t understand some of the topics. Students said they disliked maths more as they moved through the school. However more than half of all the students wrote that they liked maths. In form 3, only three boys answered the questionnaire and the two who disliked maths may have been two out of the whole group of six, which would have reversed the percentages for the boys in form 3.
The reasons given for liking mathematics were:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Form 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility</td>
<td>63%</td>
<td>68%</td>
<td>39%</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>Ability</td>
<td>10%</td>
<td>16%</td>
<td>27%</td>
<td>12%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attributes</td>
<td>25%</td>
<td>16%</td>
<td>24%</td>
<td></td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>Other factors</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 38: Reasons for liking maths

Only one student gave having a good teacher as her reason for liking mathematics.

The most popular reason for liking maths given by both boys and girls was the fact that it is considered necessary for their future careers.

The reasons for disliking mathematics were:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Form 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of ability</td>
<td>70%</td>
<td>45%</td>
<td>68%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attributes</td>
<td>30%</td>
<td>55%</td>
<td>32%</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Other factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 39: Reasons for disliking maths

None of the students blamed poor teaching for their disliking the subject. Form 3 boys stated that maths was boring, whilst form 4 boys said that they forgot work covered in class very quickly.

A large percentage, 30% for the girls and 44% for the boys, said they could not understand how students could enjoy mathematics. Yet, only eleven girls out of two hundred and twenty-eight girls (4.8%) and one boy out of the nine boys (11%) who completed the questionnaires replied that they never enjoyed the subject.
The students declared themselves to be generally confident about mathematics. Only a few of the girls (6%) said that they were never confident. All the boys felt confident about mathematics some of the time. 22% of all the students stated that they always felt confident about maths’ tests, though a greater percentage of girls (17%) than boys (11%) said they never felt confident about tests.

When it came to looking at maths’ problems, 10% of the girls stated that they always felt nervous, but almost double that number (19%) stated that they were never nervous when faced with maths problems as opposed to 11% of the boys.

71% of the girls still considered they were lucky if they did well in a maths’ test though 6% did not feel that luck played any part if they did well. 78% of the boys’ felt they were lucky if they did well, with 11% not feeling that luck had any part of it. The girls mainly attributed success in maths to working hard (85%) and having a good teacher (48%); similarly the boys: working hard (89%) and having a good teacher (44%).

If they did badly, just over half of the girls (57%) blamed themselves for their lack of effort, 29% declaring the work to be too hard. 19% felt they were always hopeless if they did badly. 44% of the boys blamed themselves for their lack of effort but an equal percentage said the work was too hard.
Mathematics as a male domain and male domination

A greater percentage of girls said that they understood new ideas quickly, though a greater percentage of boys stated that they always got most of their maths right. 6% of the girls said that they never got most of their maths right. Nineteen of the girls (8%) and two of the boys never saw the point of what they did: the largest number of girls were in form 3, both the boys were in form 4. 12% of the girls said they were nervous when asked questions in class though 28% were never nervous when faced with that situation.

The competitive nature of boys hardly arises in this school but the question of whether boys liked to beat girls at maths was left in and the girls’ responses were evenly spread. Two-thirds of the boys who completed the question responded always. Some girls in forms 2 and 3 felt that there should also have been the question: “Do girls like to beat boys at maths?” Some girls in form 3 suggested the questions: “Can girls beat boys at maths if they try hard?” and “Do girls feel proud when they beat boys?”

Other issues

Which of the topics in mathematics did the students prefer?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Form 1</th>
<th>Form 2</th>
<th>F.3 girls</th>
<th>F.3 boys</th>
<th>F.4 girls</th>
<th>F.4 boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>48%</td>
<td>31%</td>
<td>22%</td>
<td>33%</td>
<td>20%</td>
<td>17%</td>
</tr>
<tr>
<td>Comm. Arith.</td>
<td></td>
<td></td>
<td>30%</td>
<td></td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td>18%</td>
<td>45%</td>
<td>11%</td>
<td>53%</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Graphs</td>
<td>4%</td>
<td>6%</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
<td>34%</td>
<td>16%</td>
<td>24%</td>
<td>35%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>Statistics</td>
<td>8%</td>
<td>5%</td>
<td>33%</td>
<td>4%</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2%</td>
<td></td>
<td>10%</td>
<td>33%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>No answer</td>
<td>8%</td>
<td>2%</td>
<td>10%</td>
<td>33%</td>
<td>2%</td>
<td></td>
</tr>
</tbody>
</table>

Table 40: Favourite topics in maths
The boys do not seem to favour geometry although they may perform better than girls in this area. The percentages for girls liking algebra in forms 2 and 4 are encouraging.

From the data provided the girls spent more time doing homework than the boys: 41% of the girls spent more than \( \frac{1}{2} \) hour, 33% of the boys, whilst 44% of the girls spent about \( \frac{1}{2} \) hour, 33% of the boys. The girls were more likely to find maths easy if they worked carefully, but 5% of the girls said that they never found mathematics easy.

Did the students enjoy answering the questionnaire?

<table>
<thead>
<tr>
<th></th>
<th>Form 1</th>
<th>Form 2</th>
<th>F.3 girls</th>
<th>F3 boys</th>
<th>F.4 girls</th>
<th>F.4 boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>97%</td>
<td>96%</td>
<td>84%</td>
<td>33%</td>
<td>88%</td>
<td>67%</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not really</td>
<td>2%</td>
<td>4%</td>
<td>8%</td>
<td>67%</td>
<td>6%</td>
<td>33%</td>
</tr>
<tr>
<td>No answer</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 41: Percentages showing students responses to the questionnaire

The students were very responsive to the question about enjoying the questionnaire. The girls welcomed the opportunity of sharing their opinions, being able to be open about their problems with mathematics and "say how they really feel". Many stated that it helped to show them the importance of mathematics and enabled them to recognise areas of weakness. They were encouraged and pleased to know that someone cared. Several hoped that the researcher could in fact help them. Some girls in form 2 considered that the questionnaire should be used in other subject areas. A few did not enjoy answering the questionnaire as they couldn’t see any reason to it and one girl felt that it wouldn’t change anything.
The boys’ reasons for enjoying the questionnaire were that it made them think, it gave them the opportunity to say how they felt and it may help them improve. Some boys wondered why the researcher wanted to know the answers.

What changes would they make to the questionnaire? The biggest changes referred to the question about boys beating girls at maths and they have already been mentioned. In form 4, one female student felt that students did not feel that strongly about mathematics and she would have changed the opening statement. Some girls suggested asking the question: “Have you ever been nervous in maths lessons?” Two girls in form 3 did not like the question: “Do you have to be clever to do maths?” Another girl did not like the question: “Are you lucky when you do well in a maths test?”

Nearly all the students had questions to ask of the researcher and they were similar in each year: Why is mathematics so important and does one really need to study it? Many asked why maths was so difficult, particularly for girls, why they failed when they tried so hard and how they could improve in mathematics. They wanted to know how they could like or enjoy mathematics and how they could become more confident. Form 1 students were interested in finding out about university courses and the jobs they could get if they did well in maths. There were also particular questions on maths’ topics from students in all years. Some students asked about teachers’ attitudes and punishments for failing. Students in the higher forms were increasingly anxious about the situation whereby they easily forgot the work and they need to be taught study skills.
Second teachers’ questionnaire

Whereas only one questionnaire was returned from the first teachers’ questionnaire, all three maths’ teachers returned the second questionnaire. There was no major diversity in the responses. Two teachers stated that teachers tended to emphasise the difficulties of mathematics, one stated sometimes, yet all the teachers said that they do not tell their students that they have to be clever to do mathematics. Two of the teachers stated that they did not tell their students that they were no good at mathematics, though one replied sometimes.

The teachers were unanimous in expecting enjoyment in their lessons and believing that they instilled confidence in the subject. From the students’ responses (page 124) the teachers would appear to be successful in this area of their teaching mathematics.

Only one teacher gave consideration to the question about removing students’ apprehensions about the subject. He thought that mathematics had to be demystified: that one should be simple when explaining mathematics concepts and teachers should emphasise the application of each mathematical topic.

Unanimously the teachers felt that teaching should be relevant to the students and again the teachers would appear successful, this time in making their teaching relevant. Cross-curricular activities do not have a high profile as none of the teachers actually mentioned another curriculum area that could be helpful to mathematics teaching.
All the teachers declared the ability range too large, two of them wishing to group the students according to their ability so that the slow learners would be in their own group. For the slow learner, it was suggested that more time be taken to explain the topic and that the students be given more time to complete work. It was also suggested that the teacher should build on past experience and knowledge when presenting new ideas and that there should be fun when learning. All the teachers sought to encourage the students in their own ways. For one it was to give the students simple questions leading on to more difficult ones, for another it was to appreciate their weaknesses and give individual help. That teacher endeavoured to be positive about all the students’ answers even when they might not necessarily be correct. The third teacher sought to encourage students by marking their work. It needs to be remembered that students have homework after every lesson and so this is not a once or twice a week proposition.

The main obstacles to being more successful were the extensive syllabus, the limited resources, the large classes and large ability range and the attitudes of the students. Difficult topics and low I.Q. students also inhibited success.

However, their students have encouraged all the teachers and one teacher mentioned the students who came up with their own questions to do in class. There were no immediate insights from any of the teachers though the impression gained from them was one of caring teachers who wished to be more successful for their students.
School D:

Background information

School D is different from the other three Kenyan schools in many respects:

1. It is an all girls' school with a female head teacher and one looked for
evidence of more positive attitudes towards mathematics from the girls.

2. It requires a higher standard of entry and is a higher achieving school.

3. It is a Roman Catholic boarding school with the mission to educate and uplift the position of women in the Kenyan community.

4. It was chosen specifically for this research.

The school has six mathematics' teachers of whom one is female. The student body consists of three hundred and twenty-eight girls:

<table>
<thead>
<tr>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>85</td>
<td>78</td>
<td>80</td>
<td>328</td>
</tr>
</tbody>
</table>

Table 42: Students in the school

There are two classes in each year group, the largest class size being 43. Students need to gain over 470 out of 700 marks in the Kenyan Certificate of Primary Education (KCPE) to be able to apply for admission. In the 1999 KCSE examination, the school was second in the district with a mean score of 7.95 on the 12-point scale (66%). The mean maths score for the school was 4.51 (38%); the lowest compared to other subjects.

The head teacher undertook the distribution of the questionnaires and 321 (98%) were returned. The students' questionnaire was adjusted (Appendix D) to look solely at the subject of mathematics, not wishing to highlight any issues of gender.
Best/worst subjects

How do the students compare mathematics to their other subjects? Is the subject rated highly? What is best? Is it their favourite subject, one they enjoy or a subject where they gain the best grades? Similarly, what is worst? Do they perform badly in these curricula areas, or do they dislike the lessons or their particular teachers? Students all gave three best subjects, some giving more and then only the first three were taken.

<table>
<thead>
<tr>
<th>Form 1</th>
<th>Maths 40% Equal first with biology and history</th>
<th>Chemistry 34%</th>
<th>English 32%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 2</td>
<td>Maths 49%</td>
<td>Physics 43%</td>
<td>History 39%</td>
</tr>
<tr>
<td>Form 3</td>
<td>Maths 48%</td>
<td>Chemistry 45%</td>
<td>Biology 34%</td>
</tr>
<tr>
<td>Form 4</td>
<td>Biology 45%</td>
<td>Chemistry 44%</td>
<td>Maths 41%</td>
</tr>
</tbody>
</table>

Table 43: Students best subjects

Almost 45% of all the students gave mathematics as one of their three best subjects, mathematics coming first in forms 1, 2 and 3. Looking at the responses to other parts of the questionnaire there was no clear indication as to why they have chosen mathematics as one of their best subjects. They all like mathematics and their answers are never in the extreme, but they do not necessarily perceive themselves as being good, they do not always understand new ideas quickly, they do not all enjoy the subject all the time nor are they necessarily confident.

| Form 1 | Physics 54% | Maths 21% (5th worst) |
| Form 2 | Biology 54% | Maths 14% (9th worst) |
| Form 3 | Physics 38% | Maths 12% (9th worst) |
| Form 4 | Christian Religious Education 49% | Maths 27% (3rd worst) |

Table 44: Students worst subjects
It was harder for students to find their worst subjects and they did not always give three subjects. Quite a few subjects were considered more unfavourably than mathematics and it was even more difficult trying to get a picture of these students. Some of them perceived themselves to be good at mathematics and gave reasons for liking mathematics though with some proviso. The difficulty is that some of these students whose worst subject is mathematics may well achieve much better results in the subject than others who declared it to be one of their best subjects.

The exercise cannot be considered wasted. Mathematics as a subject is regarded favourably by the students in this school. It is though difficult to reconcile this with the fact that the students perform very poorly in mathematics at the end of form 4 in the KCSE examinations.

**Reasons why students may find mathematics easy/difficult**

The students were asked to give three reasons why mathematics may be considered easy and three reasons why the subject may be difficult. They have thought very carefully about their responses and very few of them were unable to give three very different reasons for each part. From their answers it was not possible to ascertain whether the individual found mathematics easy or not.

- **Finding mathematics easy:**

Easy has been interpreted by the students as succeeding or doing well in mathematics. These have been placed into five categories.
1. Students are naturally good, they are confident, they have a positive attitude, they like/enjoy the subject, are interested and can understand it.

2. Students work hard. They concentrate in class, practice questions, ask the teacher when they don’t understand and they do not give up.

3. The nature of the subject makes it easy. It evolves around the four rules and just playing with numbers. Students just need to apply what they know, including the formulae and don’t need a lot of note taking and cramming. There is a range of textbooks and one is not just reliant on the teacher.

4. Good teaching, either previously laying a good foundation or now, and good resources.

5. Peer pressure: positive influences or ignoring negative influences.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturally good</td>
<td>36%</td>
<td>35%</td>
<td>39%</td>
<td>23%</td>
<td>33%</td>
</tr>
<tr>
<td>Work hard</td>
<td>31%</td>
<td>29%</td>
<td>29%</td>
<td>29%</td>
<td>29%</td>
</tr>
<tr>
<td>Nature of the subject</td>
<td>23%</td>
<td>19%</td>
<td>13%</td>
<td>25%</td>
<td>20%</td>
</tr>
<tr>
<td>Good teaching</td>
<td>10%</td>
<td>15%</td>
<td>20%</td>
<td>22%</td>
<td>17%</td>
</tr>
<tr>
<td>Peer pressure</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Table 45: Reasons for finding maths easy

Throughout the school students seemed aware of the need for hard work and constant practice if they were to succeed in mathematics. Students appeared more aware of the need for good teaching as they progressed through the school and in form 4 they were less likely from their responses to rely on natural ability.

- Finding mathematics difficult:

The students considered reasons why they might fail or do badly in this subject. These have been placed into seven categories.
1. There are strong feelings about mathematics. Students hate or really dislike the subject. They have no interest, find it very boring and have a negative attitude.

2. Students are naturally poor, they feel they are hopeless, they lack confidence, feel discouraged and fail every time even when they try hard. They are nervous and panic in exams.

3. Students believe it is difficult, that they can’t do it, that they will not understand. Some students believe that only boys can do well in mathematics.

4. Students do not work hard. They don’t try hard enough or take the time to understand and learn the formulae. They do not concentrate or listen in class, they are careless, rush work, they do not practice questions or ask when they don’t understand.

5. The nature of the subject makes it difficult. It can be too complicated, the calculations too long. The formulae are confusing and unexpected questions can be asked, or questions posed in a different way. There is too much reasoning.

6. Poor teaching, students having a negative attitude towards the teacher or lack of textbooks.

7. Peer pressure.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dislike subject</td>
<td>7%</td>
<td>11%</td>
<td>17%</td>
<td>15%</td>
<td>12%</td>
</tr>
<tr>
<td>Naturally poor</td>
<td>10%</td>
<td>10%</td>
<td>14%</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>Believe it is difficult</td>
<td>21%</td>
<td>16%</td>
<td>14%</td>
<td>13%</td>
<td>16%</td>
</tr>
<tr>
<td>Do not work hard</td>
<td>33%</td>
<td>27%</td>
<td>25%</td>
<td>22%</td>
<td>23%</td>
</tr>
<tr>
<td>Nature of subject</td>
<td>16%</td>
<td>15%</td>
<td>10%</td>
<td>18%</td>
<td>19%</td>
</tr>
<tr>
<td>Poor teaching</td>
<td>13%</td>
<td>13%</td>
<td>13%</td>
<td>22%</td>
<td>15%</td>
</tr>
<tr>
<td>Peer pressure</td>
<td>1%</td>
<td>8%</td>
<td>5%</td>
<td>6%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 46: Reasons for finding maths difficult
Evidence

In form 1 over 50% of the responses involved believing the subject to be hard or the student not working hard enough. This decreased through the school and the students in form 4 were as likely to dislike the subject or blame the teacher for failing. The complexities of the subject were also more obvious as they approached the exams. The students themselves raised the issue of mathematics being a male domain and some gave this as the reason for believing that mathematics is difficult. Peer pressure was an unexpected factor that these female students raised.

Perceived ability

20% of the students considered themselves to be good at mathematics with only 10% perceiving themselves to be weak. The subject does not overawe them, only 7% considering that you had to be clever to do the subject. Some students had previously suggested that this was not a subject that girls could do, but not one of the 7% came into this category. 12% stated that they did not understand new ideas quickly, 4% never got most of their maths right.

Basic attitudes

The students have given indications that they are favourably disposed towards mathematics, but do they actually like the subject? A few students gave reasons for liking and disliking maths. Which ever they gave first has been taken as their preference. 14% of those liking mathematics gave reasons why they also disliked it, 9% disliked it but also found reason to like it. 2% of all the students gave reasons for neither liking nor disliking maths and one student didn’t answer.
Table 47: Percentages showing students liking/disliking maths

<table>
<thead>
<tr>
<th></th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like</td>
<td>70%</td>
<td>78%</td>
<td>85%</td>
<td>70%</td>
<td>76%</td>
</tr>
<tr>
<td>Dislike</td>
<td>30%</td>
<td>22%</td>
<td>15%</td>
<td>30%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Care has to be taken not to assume that the students increasingly like mathematics until they reach form 4. These are different cohorts of students and the proportion of students in form 4 liking mathematics may have stayed constant.

Many of the reasons given for liking mathematics were repetitions of reasons for mathematics being easy:

Table 48: Reasons for liking maths

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility</td>
<td>24%</td>
<td>41%</td>
<td>50%</td>
<td>37%</td>
<td>39%</td>
</tr>
<tr>
<td>Ability</td>
<td>27%</td>
<td>18%</td>
<td>16%</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>Attributes</td>
<td>46%</td>
<td>36%</td>
<td>32%</td>
<td>43%</td>
<td>38%</td>
</tr>
<tr>
<td>Other factors</td>
<td>3%</td>
<td>5%</td>
<td>2%</td>
<td>4%</td>
<td>3%</td>
</tr>
</tbody>
</table>

It appears that it is the fact that mathematics is useful, helps them in other subjects and especially when planning for a career that motivates these students into liking mathematics: liking is cognitive rather emotional.

The reasons for disliking mathematics were similar to the reasons for mathematics being difficult. Only two students stated that they had no interest in mathematics and couldn’t see the point of learning this subject.

Table 49: Reasons for disliking maths

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability</td>
<td>50%</td>
<td>50%</td>
<td>77%</td>
<td>26%</td>
<td>48%</td>
</tr>
<tr>
<td>Attributes</td>
<td>42%</td>
<td>41%</td>
<td>23%</td>
<td>39%</td>
<td>38%</td>
</tr>
<tr>
<td>Other factors</td>
<td>8%</td>
<td>9%</td>
<td>35%</td>
<td>14%</td>
<td>14%</td>
</tr>
</tbody>
</table>
Form 3 students who disliked mathematics acknowledged that it was just too hard: they tried but did not succeed. Form 4 students tended to blame poor teaching.

44% of the students stated that they always enjoyed the subject, with 1% saying that they never enjoyed it; 53% always enjoyed solving mathematics problems whilst 2% said they never enjoyed solving them.

**Confidence**

30% said they always felt confident about the subject, 28% about maths' tests. 5% never felt confident about maths, rising to 12% when it came to tests. Almost a half of all the students (48%) said they never felt nervous when asked a question in class, 10% always did feel nervous. 29% never felt nervous when they looked at a maths' problem, 8% always did. These percentages demonstrate a confidence and a lack of nervousness with regards to mathematics in this school.

If I do well in maths it is usually because:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I'm naturally good at maths</td>
<td>11%</td>
<td>21%</td>
<td>16%</td>
<td>11%</td>
<td>15%</td>
</tr>
<tr>
<td>I have a good teacher</td>
<td>50%</td>
<td>73%</td>
<td>63%</td>
<td>19%</td>
<td>52%</td>
</tr>
<tr>
<td>I work very hard</td>
<td>95%</td>
<td>92%</td>
<td>92%</td>
<td>92%</td>
<td>93%</td>
</tr>
<tr>
<td>The work is very easy</td>
<td>15%</td>
<td>4%</td>
<td>11%</td>
<td>1%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Table 50: Reasons for doing well in maths

The students mainly attributed doing well to working very hard. In form 4, where the students stated that having a good teacher was important, they were less likely to acknowledge that the teacher contributed to their success. In form 4 they were not finding the work very easy. Eleven students (3%) did not answer this section.
If I do badly in maths it is usually because:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Form 1</th>
<th>Form 2</th>
<th>Form 3</th>
<th>Form 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I'm always hopeless at maths</td>
<td>24%</td>
<td>16%</td>
<td>15%</td>
<td>8%</td>
<td>16%</td>
</tr>
<tr>
<td>I did not try hard enough</td>
<td>81%</td>
<td>71%</td>
<td>93%</td>
<td>88%</td>
<td>83%</td>
</tr>
<tr>
<td>I was unlucky</td>
<td>4%</td>
<td>8%</td>
<td>10%</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>The work is too hard</td>
<td>36%</td>
<td>25%</td>
<td>26%</td>
<td>13%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Table 51: Reasons for doing badly in maths

The students in form 4 do not perceive themselves as being hopeless at mathematics or that the work is too hard. They were not given the opportunity to blame the teacher. When going through the questionnaires one felt that the students worked very hard but then they failed so they just did not work hard enough. Twenty-one students (7%) did not answer this section.

Other issues

If they worked carefully, 92% said that they found the work easy. 63% stated that they see the point of most of the maths, another 25% stating sometimes. They are expected to do about half an hour’s extra work every day. 5% said they did less and 58% said they spent more than half an hour on maths homework.

Teachers’ questionnaire (Questionnaire 2)

Whatever the responses from the teachers, almost 45% of all the students gave mathematics as one of their three best subjects. This reflects favourably on the teachers and their teaching in the school. Form 4 students were more sceptical but mathematics was still their third best subject. They were more aware of the need for good teaching and how poor teaching hinders students’ ability to learn.
It was difficult getting these teachers' questionnaires returned. Only one questionnaire was returned originally. It took four visits to the school to obtain all of the questionnaires. This was considered necessary as it was the only communication with these teachers.

The diversity of responses was interesting. Two teachers stated that teachers tended to emphasise the difficulties of mathematics, three including the female teacher, stated sometimes, one stated no. The students' responses did not indicate that mathematics being difficult was a major issue: they were less inclined to give it as a reason for doing badly as they progressed through the school.

Four of the teachers responded that they did not tell students that they have to be clever to do mathematics and those four teachers never told their students that they were no good. One teacher responded yes, he did tell students that they have to be clever to do maths and that same teacher sometimes told students that they were no good. The sixth teacher responded sometimes to both questions. 80% of the students said that you did not have to be clever to do maths.

All the teachers expected enjoyment in their lessons and only 1% of the students never enjoyed maths. Four teachers felt they instilled confidence in the subject, the fifth teacher sometimes and one teacher felt that he did not instil confidence in the subject. 5% of the students never felt confident, rising to 12% when they had a test. Unanimously the teachers felt that teaching should be relevant to the students though 12% of the students never saw the point of what they did.
Evidence

Five out of the six teachers declared the ability range too large. Their concern for the weaker students in the group and the need to involve them in the lessons was enlightening. Individual attention and group work were the main solutions when faced with a large ability range.

All the teachers were aware of students’ apprehensions about mathematics and they wished to demystify the subject, make it enjoyable, involve students in the lessons, give them confidence, give them plenty of practice and encourage them at all times. Sometimes the teacher had to stop becoming too serious and relax.

Encouraging the students was deemed important and many ideas were forthcoming. These included: reminding students all the time of their abilities, working towards a positive attitude in mathematics, rewarding good performance, not making discouraging remarks, involving them in the lessons, creating a rapport with them, simplifying ideas, working from the known to the unknown. They also included giving them lots of practice, marking their work and indicating the relevance of the subject for their future careers.

Group work was emphasised by half of the teachers including the female teacher. For the slow learner, two teachers suggested remedial lessons. Others suggested spending extra time with the student to review the work, to look for a connection between work already understood and the new work and to give extra practice. Constant revision was deemed essential.
The main obstacles to being more successful were the extensive syllabus, limited time and limited resources, large classes and large ability range and the attitudes of the students. The student-centred approach was offered as the way forward: involving the students in the lessons and being democratic. Teachers had to be encouraging and patient. One teacher would like a special campaign to sell the idea of simplicity of mathematics at departmental level throughout Kenya. All the teachers have been encouraged by their students, whether the students had been successful or not.

School E:

Background information

School E is an international boarding school preparing students for the IGCSE, the international GCSE examinations. There has been a preparatory school on the site since 1931, but the senior school only started in September 1988. The school has a good reputation in the countries of East Africa, attracting students from Uganda and Tanzania as well as from Kenya.

There are three years in the senior school, S1, S2 and S3. It is slowly expanding so that there will be three classes of twenty students in each year by September 2001. In 2000, 88.5% of the students in the final year gained grade C and above in all their subjects at IGCSE including mathematics. Many, on leaving the school, go to the U.K., North America or South Africa to continue their education.
The school year is based on the English system and starts in September. Thus this study ran from September 1999 to July 2000. A few students come from the 8-4-4 system and they either start in September and take the primary school exams in October/November, or they start at the school in January.

There is an entrance examination but most of the students progress from the preparatory school. The researcher was the only full time maths teacher during the period of research but four other teachers, two male and two female, taught some mathematics. There were one hundred and forty students:

<table>
<thead>
<tr>
<th></th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>30</td>
<td>19</td>
<td>15</td>
<td>64</td>
</tr>
<tr>
<td>Girls</td>
<td>27</td>
<td>26</td>
<td>23</td>
<td>76</td>
</tr>
</tbody>
</table>

Table 52: Students in the school

Examination results, June 2000

Two boys and three girls sat the additional mathematics' paper, one boy and one girl getting an A grade, the other three reached a B grade. 74% of the students taking mathematics IGCSE in S3 gained grade C and above. Of those getting A* or A grades (24%), three were boys and six were girls. For five girls and three boys (21%) maths was their worst examination result. Looking at the ratios:

<table>
<thead>
<tr>
<th>Student numbers</th>
<th>A* and A grades</th>
<th>Worst subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:23 = 1:1.5</td>
<td>3:6 = 1:2</td>
<td>3:5 = 1:1.7</td>
</tr>
</tbody>
</table>

Table 53: Boy to girl ratios

There were more girls, but the ratio in achievement terms was increased for the girls in both the top and the bottom ability bands. There was a 1:2 (boy:girl) ratio in the top and bottom sets and an equal number of boys and girls in the middle set.
Teachers' questionnaire

All those who taught some mathematics completed the first questionnaire. One of the teachers is a Kenyan graduate from Nairobi University. She was the only person to state that girls always attribute failure to lack of ability. She was also the only person to state that it was never more important for boys to do well. The responses are given in Appendix G. The male teachers tended more to the extreme, though it was the one teacher who stated never each time. However both male teachers were emphatic that students don't need teachers of the same sex as themselves. Generally the responses were less extreme.

All the female teachers responded that sometimes mathematics is a male domain though almost all the teachers considered that boys hardly ever set the pace of work nor that they received more teacher time. Some responses suggested the possibility of gender differences in mathematics. Both male and female teachers considered that boys are generally confident and that boys sometimes blame failure on lack of effort, also that boys were better than girls at geometry. Both male teachers felt that generally girls do more homework than boys do and that girls are neater than boys. The female teachers were agreed that girls are sometimes influenced by failure feedback.

Comparing the answers of the Kenyan teacher and the other two female teachers, there is no conformity of answers suggesting that the Kenyan teacher was isolated in her responses other than for the two statements already mentioned.
Students' questionnaire

There was a 100% return and very few questions were unanswered. In responding to the statements, 1.8% were not answered by the girls, 1.5% by the boys, and there appeared to be no pattern of non-response.

The importance of mathematics

The girls in S1 and S3 were more inclined to say that mathematics was very important than the boys. The percentage of girls in S2 was less than that of the boys in responding to the same question. The boys in S1 and S2 were more inclined to say that knowing maths will help get you a job but in S3 the percentage of girls was higher than that of the boys, even though the percentages for boys and girls decreased the higher they were in the school.

Perceived ability

The students are considered to be successful at mathematics (gaining a C grade or higher in the IGCSE examination) but still only 16% of all the girls and 22% of all the boys perceived themselves to be good at mathematics. In S3, the percentages were higher than the other years. 22% of the girls and 40% of the boys replied that they were good, but the girls were undermining themselves when one looks at the results. Two of the girls who had already taken the IGCSE examination a year early perceived themselves to be only average, even though one had gained an A grade and the other a B grade. Both boys who took the examination a year early perceived themselves to be good together with the third girl.
15% of all the girls and 14% of all the boys perceived themselves to be weak at mathematics so they would not appear to be exaggerating their weakness. 22% of the girls and 27% of the boys failed to gain a C grade.

18% of the girls and 19% of the boys stated that you had to be clever to do maths though 41% of the girls and 50% of the boys stated no. Did being weak in mathematics predetermine the response to this question of needing to be clever to do mathematics? Out of the eleven girls who perceived themselves to be weak, the responses were spread 4:3:4. Eight boys considered themselves weak and their responses were 4:3:1. Thus the weak boys were more likely to state that you had to be clever to do maths.

Basic attitudes

Did the students like or dislike mathematics?

<table>
<thead>
<tr>
<th></th>
<th>Like</th>
<th>Dislike</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S1</td>
<td>S2</td>
</tr>
<tr>
<td>Girls</td>
<td>75%</td>
<td>52%</td>
</tr>
<tr>
<td>Boys</td>
<td>78%</td>
<td>65%</td>
</tr>
</tbody>
</table>

Table 54: Percentages showing students liking/disliking maths

This is not a longitudinal study so one cannot say that the girls increasingly dislike mathematics as they progress through the school, though there is a large difference between the percentages of girls in S1 and S3 liking mathematics. There are large numbers of both boys and girls in S2 who said that they disliked mathematics.
Confidence

20% of the boys said they always felt confident about maths and about maths tests and that they always enjoyed maths. These were not the same students. Always feeling confident in maths did not follow from students perceiving they were good at mathematics. The percentages were smaller for the girls.

35% of the girls and 20% of the boys said that they were lucky when they did well in a test. When asked for reasons for doing well the percentages were lower for the girls than the boys both with regards to working very hard and accrediting success to the teacher. If they did badly, 7% of the girls and 15% of the boys said that they were unlucky. 92% of the girls and 85% of the boys declared they would not have tried hard enough and almost equal percentages, 36% of the girls and 35% of the boys would do badly because the work was too hard. One girl blamed the teacher; 8% of boys and girls felt that they were hopeless.

Mathematics as a male domain and male domination

The boys were less nervous than the girls were when looking at maths problems or when asked a question in class. Students generally enjoyed solving maths problems more than they actually enjoyed maths, 25% for the girls an increase of 5%, and 38% for the boys, an increase of 18%. Quite large percentages of students, 20% for the girls and 16% for the boys, declared that they did not see the point of most of the maths that they do, the greatest number being in S2. Boys were less likely to find maths easy if they worked carefully but more said they understood new ideas quickly and that they got most of their maths right.
Is there a competitive element between the girls and the boys? 52% of the girls stated that boys always liked to beat them, whereas 47% of the boys stated the same. 13% of the girls and 12% of the boys stated never.

Other issues

When it came to favourite topics algebra was preferred by both the boys and the girls in all three years, geometry coming second for all the students.

An equal proportion, 11% of boys and girls, spent less than ½ hour on their prep. and the girls were more likely to say they spent more than ½ hour than the boys. The largest percentage of boys doing more than half an hour was 47%, the boys in S3. More than half the girls in S1 and S3 spent more than half an hour, whereas the girls in S2 were the least likely to spend that amount of time.

Did students enjoy answering the questionnaire?

The percentages for boys and girls were similar. 68% of all the students responding enjoyed answering the questionnaire, 4% did not and 29% not really.

There was a large difference between the girls and the boys in S3 when it came to stating their liking or disliking of mathematics. Other large differences in the whole student body were their perceived confidence about maths’ tests, where the boys appeared more confident and also in their enjoyment in solving maths’ problems. The girls were more likely to consider themselves lucky when they did well in a test and less likely to see the point of most of the maths that they did.
Chapter V: Themes and further analysis

Whilst compiling student data from the four Kenyan schools the researcher was struck by the positive attitudes that were portrayed. She had expected negative attitudes particularly from the girls. Both male and female students had expressed enjoyment of mathematics and the students considered themselves to be confident. Girls as well as boys were generally confident about tests and the girls were not generally nervous when asked questions in class, contrary to expectation. Over half the students in the four schools, girls and boys could see the point of the maths they did and considered that mathematics could be easy if they worked carefully. The evidence in these particular schools did not substantiate some of the theories promulgated by the literature from the developed countries about gender and mathematics.

Education for social mobility and individual opportunity

A strong theme from the literature about Kenyan education was the need to study hard in order to succeed in the future. Mathematics is considered necessary for career opportunities. Spender (1986), from her research in England, considered that boys were more likely to accept the career aspect of mathematics (page 41). Boys were expected to find mathematics more useful than the girls did but this was not confirmed by this research. Girls in these schools, as well as the boys, were aware of the importance of mathematics and declared this to be a reason for liking mathematics. Some female students (in school C) were asking about university courses and possible careers in form 1.
Themes and further analysis

Students have no opportunity of opting out of any parts of the mathematics curriculum, though some students (but not particularly the girls) requested this in their questions. It was only a few boys, in school A, who felt that some topics (particularly algebra) were a waste of time and could not have a use in the future.

Pedagogy of difference

This pedagogy implies that the girls are inferior. It was the reason for believing that girls were marginalised in Kenyan schools. If the female students had internalised this philosophy then they would consider themselves weak, particularly in a subject that is considered a male domain. Though the evidence generally showed that the girls perceived themselves to be weaker than the boys, the majority of girls did not regard themselves as being weak in mathematics. In schools A and B the percentages of girls in form 1, who considered they were weak, were less than those of the boys.

Girls' confidence in this subject would also be undermined. This research evidence suggested otherwise. Previous research has suggested that confidence and enjoyment are crucial indicators for female participation in mathematics in the secondary sector in America (page 43). The evidence from this research complies with that research. It was the girls' confident attitude that most struck the researcher as she was compiling the data from the questionnaires and made her look in particular at all the girls' data as well as comparing it with the boys' data.
The researcher has not been able to identify the factors that lead to this confidence. Talking with teachers had not led her to expect such confidence. The students' confidence, especially that of the girls, cannot be determined by their success in the subject, nor can it be using the new technology: graphical calculators and computers, as they are not available. Previous research findings suggested that actual participation in mathematics appeared to be connected to its usefulness (pages 33-4) and this could be the key.

Enjoyment of mathematics together with confidence was deemed necessary for female participation in lessons and it was considered to be more important for the younger pupils (page 34). In school A there was a smaller percentage in each successive form that said they enjoyed mathematics, the percentages of boys being higher than that of the girls each time. Schools B and C followed a similar trend whilst in school D the percentages increased from form 1 to form 3 with a decrease in form 4. The students' stated confidence in the subject was generally less than their enjoyment, with a small difference in school A with the form 1 girls and major exceptions in school B with form 4 boys and girls.

Male teachers

On commencing this work, the researcher had considered that the predominantly male teaching staff would penalise the female students. A closer look at the literature did not suggest that this would be the case and the researcher has not been given any evidence to suggest that there needs to be more female mathematics' teachers other than to show that women can do mathematics.
Themes and further analysis

Previous research suggested that male teachers gave more feedback (page 38) and that girls were more likely to be discouraged by negative comments from female teachers (page 43). In school A, the researcher sensed antagonism towards one of the female teachers, from boys and girls, in one of the classes. The literature gave examples of male encouragement (page 38) to female students and the male teachers were aware of the need to give praise and encouragement to male as well as female students. This is important, as the literature has suggested that teachers as well as giving more time to the boys also direct more criticism at the boys.

The teachers did not generally consider that they gave more attention to the boys. Their awareness of and sensitivity to the effects of their behaviour on pupils appears to be crucial. The teachers researched appeared to be aware of this in their responses to the second questionnaire though some of the students’ questions raise doubts as to the teachers’ actual awareness.

Students need to experience success (page 47) and very few students in any of the schools considered that they never got some of their work right. This is a subjective view, as many of them did not get work marked on a regular basis.

Indigenous education

For the Kenyans, under the indigenous system, mathematics was meaningful. The suggestion has been made that this is no longer the case (page 29). The majority of students in this research said they could see the point of the mathematics that they did.
The boys were taught mathematics under the indigenous system by playing games. This idea has continued into the western education system in Kenya. Students liked mathematics because it was just playing with numbers. It was not a response anticipated by the researcher, and was a natural response from students in the private school as well as the other four schools, and certainly not something the researcher had ever said. Whereas under the indigenous system, it was the boys who played the games, the girls now enjoy playing with numbers, possibly because of the influence of male teachers. Some of the girls in school D, the all-girls’ school, also liked mathematics because it was just \textit{playing} with numbers.

\textbf{Gender differences}

In general, girls are supposed to underrate their performance whereas boys overrate their performance in mathematics (page 45). This would not appear to be the case in Kenya as very few of the boys perceived themselves to be good at mathematics, and in discussing the results with some of their teachers it would appear that the students were realistic in their self-assessments. The responses relating to the girls’ perceived weakness have been noted (page 149).

The literature has implied that girls think mathematics is far more difficult than boys do (page 45). When this was given as a reason for performing badly or for disliking mathematics, the boys and the girls offered it almost equally. Girls, more than boys, are expected to attribute success to luck (page 45); the boys, more than girls, to attribute doing badly to not working hard enough. Again this research does not confirm previous research.
Themes and further analysis

Teachers in the schools who answered the first questionnaire agreed that girls were more hardworking. Kelly et al. (page 54) found that the girls were more hardworking with respect to homework. In the research schools the girls were not always the ones who did the most homework (see school A, page 104).

Effects of the secondary school

Teachers in research schools A and B suggested that children entered the secondary school with fixed ideas about mathematics, thinking that it was difficult and a male domain and their understanding concurred with most of the literature (page 44). This research offers evidence to the contrary.

In examining the results of the questionnaires for those students in form 1, completed in the first term by students in schools A, B and C, it would appear that they did not arrive with negative opinions about their ability. The students arrived at the secondary school stating their confidence and a liking for mathematics. Similar results were obtained from students in school D who completed their questionnaires during the second term.

Responses did indicate a lessening in confidence, a lack of perceived utility of mathematics, and a greater degree of negativity as students progressed through the secondary school. It may be that future years will give different results. These are different cohorts and this is not a longitudinal study, so the perceived enthusiasm of the students in form 1 may possibly be sustained as they continue through the schools.
Mathematics

Some of the prejudices against mathematics were not evidenced in the data received from these schools. Certainly some students felt helpless when it came to calculations and one needs to empathise with the students for whom mathematics just gave them a headache.

Algebra was not the major hurdle that one expected (page 27). It was a favourite topic given by more than half of the students responding to the questionnaire in forms 3 and 4 of school A, form 4 of school C and form 2 of school D. Only a few boys in school A queried the need for algebra and disliked mathematics because of it. Many students gave algebra as a reason for liking mathematics. “It is just a matter of learning the formulae”. Certainly the idea of just learning the formulae and not doing a lot of reading appealed to several students, particularly the boys.

In the first school that the researcher had been involved with, she arranged to teach a class. She volunteered to do that topic which the teacher most disliked and was presented with graph work. The researcher inferred that the teacher thought she was not doing it well (page 85) and this concurs with Ainley’s work (1995) (see page 27). Some students in school B, when asked their most difficult topics had mentioned graph work. However, some students in all the schools wrote down some aspect of graph work as their favourite topic.
Pupils' attitudes

As previously stated, the researcher was struck by the positive attitudes portrayed by the students. The teachers however considered that the negative attitude of the students inhibited their achievement and so there is a contradiction in the evidence. It could be that the teachers were being successful in their efforts to inculcate a positive approach to the subject or possibly this research generated some enthusiasm. It could possibly be the reason for invalidating this research. The students wished to please the researcher and gave the responses they felt that she expected, especially as she was European. The researcher is using her experience as a teacher in England, Canada and Nepal to consider the research valid. She has seen the students in the class rooms, she has taught some of the students and as it has been stated (page 82) the manner of making the responses showed that they were carefully completed and that the students did wish to share their own feelings.

The focus of this thesis has been gender differences. Several girls were aware of the notion that maths is a male domain. The evidence has been analysed for each school separately. In schools A and B the researcher has looked particularly at the areas where gender differences were expected from the students' responses. In schools C and D the researcher has looked for evidence to show that the girls in these two schools have more positive attitudes than the girls do in schools A and B. For school E the researcher has again looked particularly at the areas gender differences were expected from the students' responses. A final section has examined the girls' responses across all the schools.
School A

Boys are expected to see the point of mathematics more than the girls do. They seem to enjoy the subject more and are more confident. Girls are expected to consider that it is luck when they do well in tests, that maths is difficult when they perform badly. They are more likely to perceive themselves as being hopeless when they perform badly and be nervous when they are asked questions in class.

Positive aspects

The positive aspects of mathematics, where the percentages for the boys are expected to be higher than those of the girls.

1. The boys will see the point of mathematics more than the girls do.

![Students who see the point of most of the maths that they do](image)

Figure 1: Bar chart showing students who see the point of the maths

The boys in school A are not more likely to see the point of most of the maths that they do. The percentages for the girls are higher in forms 1 and 4. The girls in form 2 were the least likely to give a positive answer and for boys and girls seeing the relevance of the mathematics decreased as they progressed through the school.
2. The boys will enjoy mathematics more than the girls do.

![Bar chart showing students always enjoying mathematics](image)

Figure 2: Bar chart showing students always enjoying mathematics

The students in school A conform to the expected pattern. Boys said they enjoyed mathematics more than the girls said that they enjoyed the subject in each year and the percentages declined in each year through the school.

3. The boys will be more confident about mathematics than the girls are.

![Bar chart showing students who are always confident about mathematics](image)

Figure 3: Bar chart showing students who are always confident

The percentage of girls in form 1 stating they were always confident about mathematics was higher than the boys in form 1 thus changing the expected results.
Themes and further analysis

Negative aspects

The percentages for the girls are expected to be higher than the boys' percentages.

1. The girls consider that they are lucky when they do well in tests.

   ![Figure 4: Bar chart showing students who think they are lucky](image)

   In forms 1 and 4 there are large percentage differences (22% in form 1 and 15% in form 4) with the girls more likely to attribute their success in tests to luck. In form 2 the higher percentage is the boys.

2. The girls give the reason that that maths is difficult when they perform badly.

   ![Figure 5: Bar chart showing students who consider maths is too hard](image)

   In forms 1, 2 and 3 the percentage of boys was greater than that of the girls who gave the work being too hard as a reason when they did badly.
3. The girls are more likely to perceive themselves as being hopeless when they perform badly. Except for the girls in form 2, this was the case.

![Bar chart showing students who consider they are hopeless](image)

Figure 6: Bar chart showing students who consider they are hopeless

4. The girls are more likely to be nervous when they are asked questions in class.

![Bar chart showing students who are nervous if asked a question](image)

Figure 7: Bar chart showing students who are nervous if asked a question

In form 3 the boys apparently more nervous if asked a question in class.

The responses of the students in school A appear to generally conform to the patterns expected, though there were exceptions in six out of the seven cases submitted for this analysis. The girls in form 1 are to be noted as seeming more positive: seeing the point of the mathematics and being more confident.
School B

The students in school B were less conformist to expectations than were the students in school A.

Positive aspects

The bar charts have not been shown for these positive aspects of mathematics where the percentages for the boys are expected to be higher than the percentages for the girls. The following points indicate the areas where the percentages for the girls were higher than those for the boys.

1. The boys will see the point of mathematics more than the girls do.
   They did in forms 1 and 2, but not in forms 3 and 4.

2. The boys will enjoy mathematics more than the girls do.
   In forms 1 and 3 the percentages for the girls who always enjoyed mathematics were higher than the percentages of the boys who said the same.

3. The boys will be more confident about mathematics than the girls are.
   In form 3 the percentage of girls was greater than the percentage of boys.

For points 2 and 3, the greatest differences between the boys and the girls was in form 2. There was a 53% difference in the percentages of those who said they always enjoyed mathematics and a 29% difference in the percentages of those who said they were always confident. The differences were not so large elsewhere.
Themes and further analysis

Negative aspects

The percentages for the girls were expected to be higher than the boys' percentages.

1. The girls consider that they are lucky when they do well in tests.

![Figure 8: Bar chart showing students who think they are lucky](image)

This was not the case in form 1 and form 4 where the percentages of girls were lower than the percentage of boys attributing success in tests to luck.

2. A greater percentage of the girls are expected to give the reason that maths is difficult when they perform badly. Only in form 1 did they comply.

![Figure 9: Bar chart showing students who consider maths is too hard](image)
3. The girls are more likely to perceive themselves as being hopeless when they perform badly.

This was the case for girls in form 3 and especially in form 4.

4. The girls are more likely to be nervous when they are asked questions in class.

The exceptions here were the girls in form 2 and form 4.

There were more exceptions in school B. With regards to the positive aspects, the percentages of girls in form 3 were higher than those of the boys. With regards to the negative aspects the girls in forms 2 and 4 differed the most, with lower percentages than the boys, though there were also differences in forms 1 and 3.
School C

School C is not an all-girls' school having a few boys in forms 3 and 4 but for the purpose of this section it is considered as such and only the girls' responses have been examined. The results of school C have been compared with the girls results of schools A and B in an endeavour to see if the girls in school C were more positive and less negative than the girls in those schools. The results for each form were taken rather than the totals for each school.

Positive aspects

The three positive aspects were: seeing the point of maths, enjoying mathematics and being confident about the subject. The researcher was looking for higher percentages in school C.

1. Seeing the point of the maths that they do: the percentages for school C were lower than those of the girls in schools A and B, for all forms.
2. Always enjoying mathematics: the percentage for form 2 was higher in school C than the percentage for form 2 girls in school B and the percentage for form 4 in school C was higher than the percentage for form 4 girls in both schools A and B.
3. Always being confident about mathematics: the percentages for the girls in this school were lower than those for the girls in schools A and B.

Having very few boys has not generally increased the percentages of the girls with regard to the positive aspects. Has it lowered the percentages with regards to the negative aspects?
Themes and further analysis

Negative aspects

The researcher was looking for lower percentages from the girls in school C.

1. Considering themselves lucky when they did well in tests: in none of the forms was the percentage the lowest when comparing these results with those for schools A and B.
2. Thinking that mathematics was too hard when they did badly in maths: the percentage of girls in form 1, in school C, was lower than for the other two schools, otherwise school C did not produce the lowest percentages.
3. Thinking that they were always hopeless when they did badly in maths: the percentages were lowest this time in school C for forms 1, 3 and 4.
4. Being nervous when asked a question in class: only the form 4 girls in school C produced a lower percentage in this respect.

It cannot be stated from this research that the girls do better if they are in an almost single-sex environment. There are a few exceptions in the results but no overwhelming evidence to suggest that the girls in school C are doing better than the girls in schools A and B who are in a less “female-friendly” environment.

School D

As this school has a better academic intake than the other three schools the percentages for the positive aspects are expected to be higher, the percentages for the negative aspects lower than those in the other schools. It will not though confirm anything about a single-sex environment.
Positive aspects

The overall percentages for the girls in the four schools have been used when examining the three positive aspects.

1. Seeing the point of the maths that they do: the percentage for school D was higher than the percentages for the girls in the other three schools, the largest difference was with school C.

2. Always enjoying mathematics: the percentage for school D was higher again than the percentages for the girls in the other three schools but the differences were small.

3. Always being confident about mathematics: the percentage for the girls in school A were higher than for school D.

The girls may be considered to be reasonably positive about mathematics in these three areas. They appear more positive than the other schools but, as been stated, this may be more evidence of their ability than the single-sex environment.

Negative aspects

The percentages for each form have been compared.

1. The students in school D were not asked the question about being lucky when they did well in tests.

2. Thinking that mathematics was too hard when they did badly in maths: the percentage of girls in forms 3 and 4 were the lowest when comparing the four schools.
3. Thinking that they were always hopeless when they did badly in maths: the percentages were again lowest for the girls in forms 3 and 4 of school D.

4. Being nervous when asked a question in class: the lowest percentage of girls who always felt nervous was in school D, the highest percentage of girls who never felt nervous was also in school D.

In two out of the three aspects considered, the girls in forms 1 and 2 of school D were not less inclined to be less negative than the girls of the other three schools. The most positive results for school D were those relating to being nervous when asked a question in class.

The researcher has not been able to produce evidence from her research schools to show that Kenyan girls will perform better and be more favourably disposed towards mathematics in a single-sex environment.

School E

For this school there may again be an effect of the boys upon the girls. The year percentages have been used. The researcher has not compared the results with the other schools, leaving that for the conclusions.

Positive aspects

1. Seeing the point of the maths that they do: the percentages were higher for the boys in S1 and S2. The percentage for the girls in S3 was slightly higher than that of the boys.
2. Always enjoying mathematics: the percentages were higher for the girls in S1 and S3. The overall percentage for boys and girls who said they always enjoyed mathematics was 20%. A higher percentage of boys stated they never enjoyed maths.

3. Always being confident about mathematics: the percentages for the boys were higher than the percentages of the girls in each year. Whereas the percentage of boys who said they always enjoyed maths was very low in S3, those same boys expressed greater confidence in the subject.

Only in the area of confidence were the percentages for the boys consistently higher than those of the girls. However, the overall percentage for the boys relating to seeing the point of most of the mathematics was also higher than that of the girls.

Negative aspects

1. Considering themselves lucky when they did well in tests: the girls were more likely to consider that they were lucky when they did well in a maths’ test, thus conforming with the literature.

2. Thinking that mathematics was too hard when they did badly in maths: the percentages of girls in S1 and S3 were higher than the percentages of boys, but lower for S2.

3. Thinking that they were always hopeless when they did badly in maths: the percentages were similar for the girls and the boys: five out of sixty-four boys and six out of seventy-six girls came into this category.
4. Being nervous when asked a question in class: the only difference was the few girls in S3 who said that they were always nervous.

Again, there is no evidence from this research to consolidate previous work relating to gender differences in mathematics. Only in two of these seven possible areas does this data confirm previous research findings: the girls in this school appear to be less confident than the boys are and more likely to feel they are lucky when they do well in tests.

Overview of the girls' results in the four Kenyan secondary schools

The researcher in this section has endeavoured to investigate the girls' responses to the questions more fully. She has wanted to emphasise the positive nature of the girls' responses in the four Kenyan secondary schools. The results were then compared with the girls in school E before investigating whether the number of boys in the school may have influenced the attitudes of the girls towards mathematics.

The researcher expected the girls to perceive themselves to be weak at mathematics. From the questionnaires returned from the four Kenyan schools, 21% considered themselves weak, but 9% were able to state that they were good. It was thought that the girls would consider that you had to be clever to do mathematics. 34% of the responses complied but 48% considered that you did not have to be clever to do maths.
In matters of confidence, surely more girls would respond never than always. However, 28% stated that they were always confident, 29% when it came to tests. Only 4% were never confident though the percentage rose to 14% when anticipating tests. Does this confidence imply a lack of nervousness when asked a question in class and when looking at maths problems? This appeared to be the case. 13% were always nervous when asked a question in class but almost three times the number (38%) said that they were never nervous when asked a question in class. 24% responded that they were never nervous when looking at maths problems, 8% were always nervous.

This would also possibly suggest enjoyment of mathematics. 39% stated that they always enjoyed mathematics, with 3% stating they never enjoyed the lessons. 47% always enjoyed solving problems, 3% never.

More than half, 54%, of all the female students who replied, saw the point of most of the maths that they did; 9% responded negatively. 82% found maths easy if they worked carefully only 2% did not consider this a possibility. 25% felt that they understood new ideas quickly with 10% feeling that they never understood new ideas quickly. This was an area of consideration by the teachers responding to the second questionnaire and they gave suggestions for overcoming the difficulty of students who found it difficult to understand new ideas. 6% of the female students said that they never got most of their maths right, a slightly higher percentage, 8%, stated that they always did. This was the question from those with the largest percentage of students circling the middle option.
These are very positive responses from the girls. How valid are the results? Were these students trying to please the researcher or their class teacher? Were they trying to manipulate a research situation? The researcher was very aware of these questions when examining the data and they have already been raised.

The students did not appear to be trying to please their class teacher, as several were open about their dislike of a teacher. As previously stated (page 82), each question appeared to have been judged on its own merit and the researcher sensed the questions had been answered with great care and consideration. She did not have this same impression when she compiled the data from the questionnaires in the original study (Nock 1997). The majority of the students were pleased to answer these questions on a personal level. They wished to convey their own sentiments and were grateful for the opportunity to do so. The students may have endeavoured to give expected answers (either please the researcher by stating that girls could do mathematics, or comply with the notion that mathematics was a male domain which their teachers considered was the thinking amongst students) if interviews had been conducted (see pages 80-1).

Another vital question is whether the more successful girls in school D affected the results? Do these results reflect the attitudes of the girls in school D and not the girls in the other schools? Out of the 886 girls who completed the questionnaire 321 were from school D, so they represented just over 36% of the sample. The girls in school D were more inclined to consider themselves to be good at mathematics as was expected, the students being more able.
A greater percentage answered that you did not have to be clever to do mathematics and 62% said they saw the point of most of the maths that they did. Still, over 50% of the girls in schools A and B also saw the point of most of the maths that they did. Otherwise there were not large percentage differences in the responses to these questions from the girls in the different schools. A greater percentage of the girls in school A said they were confident about mathematics and in schools A and B the girls appeared more confident about tests.

Female students who consider themselves to be weak at mathematics

Is it possible to construct a profile for the female students who considered themselves to be weak at mathematics? Many of them said they did not like the subject. In schools A, C and D over 50% of these students stated that they disliked mathematics. Otherwise it was difficult to categorise these students. Many still enjoyed some of the lessons. 13% of the girls who said they were weak in school A, 4% in school B and 15% in school C stated that they never enjoyed mathematics. Generally they felt some confidence in the subject with 12% of these girls in school A saying that they never felt confident, 2% in school B, 23% in school C and 13% in school D.

The main areas of difficulty were: considering themselves slow to learn new ideas (between 23% and 35% depending on the school), not seeing the point of the work they were doing (between 11% and 28%) and some never got most of their maths right (between 23% and 30%). The students highlighted different areas which indicates their thoughtfulness in completing the questionnaire.
Comparison of results with the private school

How do the results of the girls in the separate schools compare with the girls from school E, the private school where students are generally considered successful at mathematics? Does the number of boys in the school appear to influence the answers that the girls have given?

<table>
<thead>
<tr>
<th>School</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>30.8%</td>
</tr>
<tr>
<td>School B</td>
<td>56.3%</td>
</tr>
<tr>
<td>School C</td>
<td>95.4%</td>
</tr>
<tr>
<td>School D</td>
<td>100%</td>
</tr>
<tr>
<td>School E</td>
<td>54.3%</td>
</tr>
</tbody>
</table>

Table 55: The percentage of girls in each school

The responses to the statements have been grouped in pairs so that the questions of ability, confidence, nervousness and enjoyment could be considered together.

The responses about the work were also examined in pairs across the five schools. The percentages relate to the girls’ responses only.

<table>
<thead>
<tr>
<th>Perceived ability</th>
<th>Do you have to be clever?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Weak</td>
</tr>
<tr>
<td>School A</td>
<td>5%</td>
</tr>
<tr>
<td>School B</td>
<td>2%</td>
</tr>
<tr>
<td>School C</td>
<td>5%</td>
</tr>
<tr>
<td>School D</td>
<td>19%</td>
</tr>
<tr>
<td>School E</td>
<td>16%</td>
</tr>
</tbody>
</table>

Table 56: Responses relating to ability in mathematics

The girls in school D appear to compare more favourably than the girls in school E; but students from these more successful schools seem more likely to perceive themselves as being good at mathematics and less likely to think that you have to be clever to do maths. The largest percentage of girls perceiving themselves to be weak was in school A where the boys may have influenced them.
The girls in school E gave answers indicating little confidence in mathematics or when doing mathematics’ tests. School A, with the largest percentage of boys, was the school where the girls responded most positively to being generally confident. In school B the students’ replies indicated the greatest confidence with regards to tests.

The girls in school A were the most likely to be nervous if they were asked a question in class and also when looking at a maths’ problem. One may possibly infer the influence of the boys again. However, the smallest percentage of girls who said they were always nervous when asked a question in class was the girls in the private school. The boys would not appear to be dominating and intimidating the girls in this school. The girls who appeared the least nervous were the girls in schools B and D.
The results from schools B and D show greater percentages of girls who say they always enjoy mathematics, the percentage in school E are much less. Many more girls in school E stated that they never enjoyed solving maths' problems. This is the converse of what the researcher expected from school E.

School E has again produced results that are the opposite of those the researcher expected. Schools A, B and D are very close in the percentages of girls responding that they understand new ideas quickly, with school A having the largest percentage of girls who do not understand new ideas quickly. Was this again a possible influence of the boys? The boys may have appeared to the girls to understand more quickly, giving the girls the impression that they were slow. This is though, less than one fifth of the girls responding in the school. Schools B and D are the most similar when looking at students who find maths easy.
The more academic girls' school had the greatest percentage of girls who said they always got most of their maths right and they saw the point of most of the maths that they did. School E, which the researcher judged student-centred: oriented towards students understanding the work that they were doing, again produced results that suggest the opposite from the students. Certainly the responses from school E do not compare favourably with the responses from the local Kenyan schools. The girls in school E gave answers indicating little confidence in mathematics or when doing mathematics' tests and a greater percentage of the girls E stated that they never enjoyed solving maths' problems.

In school A with the greatest percentage of boys, the girls did not appear to be dominated by them. Certainly a greater percentage of the girls in that school perceived themselves to be weak and slower to understand new ideas quickly; but they also described themselves as being generally confident in mathematics.

Having looked at the evidence and various themes relating to gender and mathematics the conclusions now examine the data in relation to the five research questions that have been posed in this work.
Chapter VI: Conclusions

General responses

One is not able to generalise from case study data. However, the researcher believes that the evidence is sufficient to suggest that schools in Kenya should not be allowing themselves to accept the female prejudices against mathematics that research has found in first world countries. In seeking for equality of opportunity despite the pedagogy of difference, it would appear that the opportunity is equally there for girls as for boys as far as mathematics is concerned. Boys considered themselves to be better at mathematics in the KCSE examinations but one cannot consider a mean of 14% over the nation as being very much better than 10%, the mean for the girls. All students are performing inadequately.

The ambience in a Kenyan classroom is completely different from one in the U.K. and North America. The students do not see themselves as needing to be the centre of attention. In school B the lessons that the researcher observed did not show male domination in the classroom and time-wasting student participation in the lessons. The students are there to learn. Education is not a right, it is not free and it is not compulsory. Male dominance, despite the physical aspect of so many young men in the classroom, is not inhibiting for the female students.

Mathematics is a critical filter to further educational and career opportunities and girls are not disadvantaged. The high level of mathematics education in the secondary school is equally available for all students who complete secondary school.
Girls are as aware as the boys are of the importance of mathematics. Students do not have the opportunity to opt out of any part of the mathematics' course, other than by being disenchanted in the lessons and by failing to work. This will apply equally to boys and girls.

There may be a need for girls to have female role models in school and the Kenyan students may be disadvantaged in this respect but the literature showed that having male mathematics' teachers does not disadvantage girls. So having mostly male teachers in the Kenyan schools is not working against the girls.

Possible marginalisation of girls

If the girls were marginalised in the mathematics classes the researcher would have expected the girls to consider themselves as being weak at mathematics, never seeing the point of the mathematics that they do and never getting most of their maths right. They would consider that you had to be clever to do mathematics, mathematics could never be easy and they would never understand new ideas quickly. The responses of all the girls in the four local Kenyan schools did not comply with such expectations. Only in the area of perceived ability in mathematics was there a higher percentage of female students at the negative extreme.

With regard to confidence and enjoyment it was considered that the female students would tend to have little confidence, be very nervous and never enjoy mathematics.
The main factor differentiating the students who considered themselves to be weak at mathematics was the fact that they disliked mathematics. They still enjoyed some of the lessons and felt confident some of the time.

The researcher has not found evidence to support the theory of a pedagogy of difference in these schools. This may be due to the fact that the girls in this study are advantaged. Education is considered important for them.

The researcher has not found evidence to substantiate the supposition that these girls have been marginalised in mathematics. She considers that the research done by Driver in the U.K., albeit twenty years ago, Parry in Jamaica and Mittelberg and Lev-Ari in Israel is relevant to the situation of the Kenyan female, in that the female students, when motivated are able to cope with mathematics. In Mittelberg and Lev-Ari's work it was the Arab female rather than the Jewish female who performed well and the researcher believes there are parallels with female students in the local Kenyan schools and the private school.

As far as the female students in this study are concerned, there is evidence of positive attitudes with regards to mathematics and of a caring pedagogy. They are not failing in the KCSE examination because they are female and unable to function in a male domain. Though the students are aware that boys are believed to be better at mathematics they do not appear to be adversely affected by this. The teachers are aware of the perceived gender differences in mathematics and they are endeavouring to ensure equality of opportunity for their female students.
Conclusions

Research questions

The researcher posed five research questions. The first question looked at the attitudes of the teachers in the four Kenyan local schools with the next two questions querying the attitudes of the students in these schools. The fourth question looked for evident reasons for these students failing in the KCSE mathematics' examination, whilst the fifth question looked for differences between the students in these schools and the students from more privileged backgrounds in a different educational environment. What conclusions can be drawn from the evidence presented and what further research is needed in the area of mathematics education at secondary level?

Do the mathematics' teachers portray any obvious gender bias?

It was proposed that mathematics is considered to be a male domain. Teachers in all the Kenyan schools that the researcher has visited considered this to be the case and were happy to discuss how the situation could be improved for the girls and to ask about the researcher's own experience.

The teachers in the all-girls' school were not given the first questionnaire. This does not mean that they were not gender biased. Their manner of teaching the girls may well imply that the girls could never be as good as boys would be at mathematics. Unfortunately lesson observation and interviews were not possible in this school. Across the other schools the teachers are in a position of inevitable failure with all their students even though the message received by the researcher was one of caring and wishing to ameliorate the situation.
The lessons observed in school B were the antithesis of that mentioned in Rwanda (page 37) and reiterated the concern of the teacher for the successful completion of work by the students, male and female. The researcher hopes that it was not stage-managed for her benefit. With all her experience she does not believe so.

This researcher has no evidence to suggest that there is any obvious gender bias portrayed by these mathematics' teachers. The teachers were heartened to believe that because the researcher is a woman, then there is help for those students who are not doing well in mathematics, particularly if those students are female.

Are there gender differences in the ways the students see themselves in this curriculum area?

It was proposed that girls underrate their ability in mathematics and that they base success on hard work and luck, whereas the boys consider achievement to be based on their ability in mathematics. What are the gender differences in the two mixed schools? Are there significant differences when one compares the girls in schools A and B with the girls in schools C and D?

The evidence has pinpointed areas where the attitudes of the boys appeared to be more positive with regards to the girls. The analysis has shown that these are not consistent in each school. In each of the mixed schools there were groups of girls whose stated opinions appeared to reverse traditional gender thinking about mathematics. The researcher was not able to ascertain that the girls in schools C and D benefited by the absence of boys.
Are the boys more confident than the girls and do they enjoy the subject more?

It was proposed that the boys are more confident in mathematics and that they enjoy mathematics more than the girls and that reasons for enjoying or disliking mathematics would generate gender differences in the schools.

Many of the girls in this study have stated that they were confident in mathematics and enjoyed the subject. The tendency was for the percentages to be higher for the boys than for the girls but this was not always the case. The girls in the form 1 classes gave the impression of arriving at the secondary school with positive attitudes.

The boys appeared more likely to like mathematics than the girls did, though the percentages were still over 50% for the girls. The researcher was struck by the perceived utility of mathematics as a reason for liking mathematics and this was from the girls as well as the boys.

Are there any evident reasons for the failure of these students in the KCSE examination?

From the data analysed, were the lessons geared to examination success or failure? The researcher was not aware at any time of situations that suggested that these students were bound to fail. Attitudes of teachers and students alike were positive and caring. Behaviour around the schools and in the few lessons observed were indicative of environments where all were hard working.
To what extent was a high level of mathematics expected for all students? *Appendix H* gives a comparison between the IGCSE and KCSE examinations and syllabi. The analysis shows that the KCSE examination papers in mathematics are of a level that the students in her own school would not achieve after another year of secondary education unless they were specialising in mathematics in the sixth form. There is a great range of ability in mathematics, even at the start of secondary school. Mathematics is a subject where students may not have the aptitude for the subject but may still achieve a basic success in the subject. The researcher believes that differentiated papers are needed at the end of secondary education though she applauds the Kenyan system in its effort to provide a full mathematics' curriculum for all secondary students. Unfortunately it does build the high failure rate into that system. The researcher does not think that smaller classes and improved resources would improve the situation drastically.

What are the differences between the students researched in the Kenyan system of education and the students in the private school where the students will be successful in their mathematics' examinations?

Many of the responses from students in school E were not those expected by the researcher. It would appear that the attitudes in this school conform more to those found in the literature in the first world. Certainly these students do not have to struggle for their education and they believe they have a right to secondary and then further education.
The researcher believes that the positive attitudes of the students in schools A, B, C and D evolved from their perceived notion of the importance of mathematics and its utility factor, especially with regards to their future careers as many gave this as a reason for liking mathematics. Only 21% of the girls in school E who liked mathematics cited its utility value whilst 34% of the boys responded accordingly.

The likelihood of success in the final mathematics’ examinations does not appear to be a determining factor in students’ basic attitudes to mathematics. From the data received it appears to affect the perceived ability of the students but does not necessarily instil confidence in the students.

Students in all the schools seemed realistic about their mathematical ability, not underrating their possible achievement at the lower end of the ability range. The girls in school E did though appear to underrate their ability at the upper end of the ability range, even when they had already achieved examination success. Again this concurs with the literature.

Other features arising from the data

Achievement in mathematics has been a main feature of this work: the importance of mathematics and the need to achieve in this curriculum area; the factors relating to achievement, whether it is aspects of the subject itself or attitudes of the students. Throughout has been the notion that the gender of the student affects mathematical achievement.
Conclusions

Can one then, across the schools give a profile of the student who is good in mathematics and likely to succeed, or the converse, the student who is weak in mathematics and likely to fail? The expectation would be that the successful student would be male, the unsuccessful student female although research now suggests that boys are more likely to be at each end of the ability range. The girls neither reach the heights or the depths of the male students in mathematics.

The researcher has examined the data in order to construct such profiles and not succeeded. No distinct patterns emerged from the data. In the locality, the girls have the best educational opportunities in school D though with caring teaching individual students have achieved success in other schools.

This research has not shown that students are reluctant learners in mathematics when they start the secondary school. It is hoped that they are able to maintain their positive attitudes throughout their secondary education.

The way forward

This research has provided contradictory data to previous research in many instances. This is very important for Kenyans, as the third world countries are very much in the shadow of the first world countries. With regard to girls and mathematics, Kenyans should not consider themselves inferior. Girls who are receiving secondary education do not appear to be marginalised in this important curriculum area, and boys as well as girls are expected to achieve a much greater level of mathematical attainment than in the developed countries.
Conclusions

What reasons can be given for this?

1. Kenya is a developing country. Education is a privilege and at the moment the students in these local schools are not wasting the opportunities of schooling.

2. The motivation to do well in mathematics is very strong in these students. They are aware of the importance of mathematics if they want to continue their education and for most careers. They are aware of the utility of mathematics in other areas of their lives.

3. It is important that the educational standards are not low because Kenya is a developing country. The researcher believes that the standard of education may be deliberately high so that Kenyans moving outside the country to study at universities will not be disadvantaged.

There remains the fact that the students are failing in their end of school examinations. The curriculum is not to be changed as a result of the Koech report. All secondary schools are expected to continue to teach the extensive syllabus with its resulting failure rate.

Teachers have suggested ways that may improve their results. The syllabus will not change, the resources will not suddenly appear, it is unlikely that the class sizes will be reduced, so what hope is there? Different strategies, some suggested by the teachers, need to be shared and implemented: particularly those which involve differentiated and group work, letting the brighter students help the weaker ones and giving extra remedial work/lessons.
The researcher is to spend one afternoon a week in school C during the next academic year. She will work with the three teachers and be available to teach, assist in the classroom, to take remedial groups or devise simple resources to aid the students. It does not seem likely that performance levels will be raised but the researcher hopes that she can be an encouragement to teachers and students alike.

This study has been over one year. Attitudes to mathematics may well be changing. Teachers implied that the students were arriving at the secondary school accepting that they were already failures in mathematics and believing that it was going to be very difficult for them. The data from form 1 students did not conform to this notion. The students may be more encouraged in their primary schools and may arrive at the secondary school enthusiastic. It is important now that there should be longitudinal studies: that a group of students is shadowed through the four years of secondary education.

The researcher hopes that this research has been of benefit to the schools co-operating with this work. Certainly the teachers should be encouraged by the results of the students' questionnaires. Where there are difficulties with certain forms there is the time to possibly rectify the situation though it is too late for the form 4 students. The students said they were pleased that somebody cared. The researcher hopes they will be encouraged by her answers to their questions, which were made in writing. Unfortunately the personal contact with all the students is not possible. The researcher herself has been edified through visiting the schools and doing this work.
Appendix A

Teachers’ Questionnaire (1)  

When talking about gender issues in mathematics, the following statements are often quoted. I want to find out how applicable they are in our schools.

Please circle the number that indicates the relevant truth you would give to the statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Always (1)</th>
<th>(2)</th>
<th>(3)</th>
<th>Never (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics is a male domain</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys set the pace of the work</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys get more teacher time</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys blame failure on lack of effort</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys are confident</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys need male teachers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls attribute failure to lack of ability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls are influenced by failure feedback</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls lack confidence</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls fear being asked questions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls need female teachers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys are better than girls at number</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys are better than girls at algebra</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys are better than girls at geometry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Boys are better than girls at statistics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>It is more important for boys to do well</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls learn better than boys</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls do more homework than boys</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls are neater than boys</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Girls are more hardworking than boys</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Thank you for your time and co-operation.

(Sylvia Nock)
Appendix B

**Teachers’ Questionnaire (2)**

Students consider mathematics a difficult subject, and as teachers we are aware of those difficulties. As a teacher I appreciate the time restrictions when trying to complete a syllabus. I know that I don’t always put my good intentions into practice. As part of my research, I would like to find out how you as a teacher are trying to overcome those difficulties. Teachers in four schools are responding to these questions and so any insights will be helpful to a large number of students.

Please circle the answer that indicates your response to each statement.

<table>
<thead>
<tr>
<th>Do we tend to emphasise the difficulties of mathematics?</th>
<th>Yes</th>
<th>Sometimes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do we tell students that they have to be clever to do mathematics?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do we sometimes tell our students that they are no good at mathematics?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do we expect enjoyment in our lessons?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do we instil confidence in the subject?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
</tbody>
</table>

How can we remove students’ apprehensions about mathematics?

| Do we need to make our teaching relevant to the students? | Yes | Sometimes | No |

Which curriculum areas can be helpful in our teaching?

| Is there too large an ability range in our classes? | Yes | Sometimes | No |

What can be done to overcome this?
How can we encourage our students?

What do we do with students who find it difficult to understand new ideas?
(One of my students said that he was only beginning to understand by Friday what had been taught on Monday, and already the class was moving on to new work)

What do you consider to be the three main obstacles to being more successful in your teaching of mathematics at the present time?
1.

2.

3.

Have you any insights which you have found useful in teaching mathematics?

Have you any examples of students who have encouraged you in your teaching?

Will you please check that you have indicated whether you are male or female.
Thank you for your time and co-operation.

(Sylvia Nock)
**Appendix C**

**Students' Questionnaire**

Students often feel very strongly about their mathematics lessons.

I want to find out how students in Kenya think about mathematics.

Please circle the answer that indicates your response to each statement.

<table>
<thead>
<tr>
<th>Question</th>
<th>Good</th>
<th>Average</th>
<th>Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>How good are you at maths?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you generally feel confident about maths?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you enjoy maths?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>How important do you feel maths is?</td>
<td>Very</td>
<td>Not very</td>
<td>Not at all</td>
</tr>
<tr>
<td>How long do you tend to spend on maths homework (prep)?</td>
<td>Less than ½ hour</td>
<td>About ½ hour</td>
<td>More than ½ hour</td>
</tr>
<tr>
<td>Do you have to be clever to do maths?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do you understand new ideas quickly?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do you get most of your maths right?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you feel confident about maths' tests?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do boys like to beat girls at maths?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you enjoy solving maths' problems?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Will knowing maths help get you a job?</td>
<td>Yes</td>
<td>Maybe</td>
<td>No</td>
</tr>
<tr>
<td>Do you feel nervous when you look at a maths problem?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Are you lucky when you do well in a maths' test?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do you feel nervous if you are asked a question in class?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Can you understand how students can enjoy maths?</td>
<td>Yes</td>
<td>Maybe</td>
<td>No</td>
</tr>
<tr>
<td>Do you find maths easy if you work carefully?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do you see the point of most of the maths you do?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
</tbody>
</table>

Please turn over.
Put a ✓ in the box next to the statements which you think apply to you.

You may ✓ more than one box.

If I do well in maths it is usually because:

<table>
<thead>
<tr>
<th>I'm naturally good at maths</th>
<th>I work very hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have a good teacher</td>
<td>The work is very easy</td>
</tr>
</tbody>
</table>

If I do badly in maths it is usually because:

<table>
<thead>
<tr>
<th>I'm always hopeless at maths</th>
<th>I was unlucky</th>
</tr>
</thead>
<tbody>
<tr>
<td>I did not try hard enough</td>
<td>The work is too hard</td>
</tr>
</tbody>
</table>

What is your favourite topic in maths? ______________________

Could you write down why you like / dislike maths.

____________________________________________________________________

____________________________________________________________________

Have you enjoyed answering this questionnaire? Yes □ No □ Not really □

Why?

____________________________________________________________________

____________________________________________________________________

What would you change in the questionnaire?

____________________________________________________________________

____________________________________________________________________

What questions would you like to ask?

____________________________________________________________________

____________________________________________________________________

Thank you for your time and co-operation.

(Sylvia Nock)
Appendix D

Amended Students' Questionnaire

Form:

To find out more about students could you state your best three subjects and your worst three subjects.

Best subjects

Worst subjects

Students often feel very strongly about their mathematics lessons.

I want to find out what students in Kenya think about mathematics.

Give three reasons why students may find mathematics easy:

1. 

2. 

3. 

Give three reasons why students may find mathematics difficult:

1. 

2. 

3. 

Put a ✓ in the box next to the statements which you think apply to you.

You may ✓ more than one box.

If I do well in maths it is usually because:

| I'm naturally good at maths ☐ | I work very hard ☐ |
| I have a good teacher ☐       | The work is very easy ☐ |

If I do badly in maths it is usually because:

| I'm always hopeless at maths ☐ | I was unlucky ☐ |
| I did not try hard enough ☐   | The work is too hard ☐ |

Please turn over.
What is your favourite topic in maths? ______________

Could you write down why you like / dislike maths.

______________________________________________________________________

Please circle the answer that indicates your response to each statement.

<table>
<thead>
<tr>
<th>How good are you at maths?</th>
<th>Good</th>
<th>Average</th>
<th>Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you generally feel confident about maths?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you enjoy maths?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>How long do you tend to spend on maths homework (prep)?</td>
<td>Less than ½ hour</td>
<td>About ½ hour</td>
<td>More than ½ hour</td>
</tr>
<tr>
<td>Do you have to be clever to do maths?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do you understand new ideas quickly?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do you get most of your maths right?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you feel confident about maths’ tests?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you enjoy solving maths’ problems?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you feel nervous when you look at a maths problem?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you feel nervous if you are asked a question in class?</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Do you find maths easy if you work carefully?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>Do you see the point of most of the maths you do?</td>
<td>Yes</td>
<td>Sometimes</td>
<td>No</td>
</tr>
</tbody>
</table>

Thank you for your time and co-operation.

(Sylvia Nock)
Appendix E

Teachers' responses to questionnaire 1 (School A)

<table>
<thead>
<tr>
<th></th>
<th>Always (1)</th>
<th>(2)</th>
<th>(3)</th>
<th>Never (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics is a male domain</td>
<td>2</td>
<td>1</td>
<td></td>
<td>3/2</td>
</tr>
<tr>
<td>Boys set the pace of the work</td>
<td>1/1</td>
<td>1/1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Boys get more teacher time</td>
<td>1/1</td>
<td>2</td>
<td></td>
<td>3/1</td>
</tr>
<tr>
<td>Boys blame failure on lack of effort</td>
<td>3/1</td>
<td>3</td>
<td></td>
<td>1/1</td>
</tr>
<tr>
<td>Boys are confident</td>
<td>1/1</td>
<td>5</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>Boys need male teachers</td>
<td>1</td>
<td>2/1</td>
<td></td>
<td>3/1</td>
</tr>
<tr>
<td>Girls attribute failure to lack of ability</td>
<td>1/1</td>
<td>2</td>
<td>2/1</td>
<td>1</td>
</tr>
<tr>
<td>Girls are influenced by failure feedback</td>
<td>2</td>
<td>1/1</td>
<td>4/1</td>
<td></td>
</tr>
<tr>
<td>Girls lack confidence</td>
<td>/1</td>
<td>5</td>
<td>1/1</td>
<td>1</td>
</tr>
<tr>
<td>Girls fear being asked questions</td>
<td>1</td>
<td>3/1</td>
<td>3/1</td>
<td></td>
</tr>
<tr>
<td>Girls need female teachers</td>
<td>1</td>
<td>3/1</td>
<td>3/1</td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at number</td>
<td>3</td>
<td>1/1</td>
<td>1</td>
<td>2/1</td>
</tr>
<tr>
<td>Boys are better than girls at algebra</td>
<td>1/1</td>
<td>2</td>
<td>2/1</td>
<td>2</td>
</tr>
<tr>
<td>Boys are better than girls at geometry</td>
<td>2</td>
<td>4/1</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at statistics</td>
<td>3</td>
<td>1</td>
<td>2/2</td>
<td>1</td>
</tr>
<tr>
<td>It is more important for boys to do well</td>
<td>1</td>
<td>5</td>
<td>1/2</td>
<td></td>
</tr>
<tr>
<td>Girls learn better than boys</td>
<td>/1</td>
<td>1/1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Girls do more homework than boys</td>
<td>1/1</td>
<td>1/1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Girls are neater than boys</td>
<td>2/1</td>
<td>4/1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Girls are more hardworking than boys</td>
<td>/1</td>
<td>2</td>
<td>3/1</td>
<td>2</td>
</tr>
</tbody>
</table>
### Teachers' responses to questionnaire 1 (School B)

<table>
<thead>
<tr>
<th></th>
<th>Always (1)</th>
<th>(2)</th>
<th>(3)</th>
<th>Never (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics is a male domain</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Boys set the pace of the work</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys get more teacher time</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Boys blame failure on lack of effort</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys are confident</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys need male teachers</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls attribute failure to lack of ability</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Girls are influenced by failure feedback</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls lack confidence</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls fear being asked questions</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls need female teachers</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at number</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at algebra</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at geometry</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at statistics</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>It is more important for boys to do well</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Girls learn better than boys</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Girls do more homework than boys</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls are neater than boys</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls are more hardworking than boys</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Teachers’ responses to questionnaire 1 (School E)

#### Male 2 / Female 3

<table>
<thead>
<tr>
<th></th>
<th>Always (1)</th>
<th>(2)</th>
<th>(3)</th>
<th>Never (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics is a male domain</td>
<td>- / 3</td>
<td>1 / -</td>
<td>1 / -</td>
<td></td>
</tr>
<tr>
<td>Boys set the pace of the work</td>
<td>- / 1</td>
<td>1 / 2</td>
<td>1 / -</td>
<td></td>
</tr>
<tr>
<td>Boys get more teacher time</td>
<td></td>
<td></td>
<td>1 / 3</td>
<td>1 / -</td>
</tr>
<tr>
<td>Boys blame failure on lack of effort</td>
<td>2 / 2</td>
<td>- / 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys are confident</td>
<td>1 / 3</td>
<td>1 / -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys need male teachers</td>
<td>- / 1</td>
<td>- / 2</td>
<td>2 / -</td>
<td></td>
</tr>
<tr>
<td>Girls attribute failure to lack of ability</td>
<td>- / 1</td>
<td>1 / 1</td>
<td>1 / 1</td>
<td></td>
</tr>
<tr>
<td>Girls are influenced by failure feedback</td>
<td>- / 3</td>
<td>1 / -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls lack confidence</td>
<td>- / 1</td>
<td>1 / 2</td>
<td>1 / -</td>
<td></td>
</tr>
<tr>
<td>Girls fear being asked questions</td>
<td>- / 1</td>
<td>1 / 2</td>
<td>1 / -</td>
<td></td>
</tr>
<tr>
<td>Girls need female teachers</td>
<td>- / 2</td>
<td>- / 1</td>
<td>2 / -</td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at number</td>
<td>- / 1</td>
<td>1 / 2</td>
<td>1 / -</td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at algebra</td>
<td>- / 1</td>
<td>2 / 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at geometry</td>
<td>2 / 2</td>
<td>- / 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys are better than girls at statistics</td>
<td>- / 2</td>
<td>2 / 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is more important for boys to do well</td>
<td>1 / 2</td>
<td>1 / -</td>
<td>- / 1</td>
<td></td>
</tr>
<tr>
<td>Girls learn better than boys</td>
<td>1 / 1</td>
<td>1 / 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls do more homework than boys</td>
<td>2 / 1</td>
<td>- / 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls are neater than boys</td>
<td>2 / 2</td>
<td>- / 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls are more hardworking than boys</td>
<td>1 / 1</td>
<td>1 / 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix H

Comparison between the IGCSE and KCSE syllabi

The IGCSE examinations are taken one year earlier than the KCSE examinations. There are two levels of entry: core and extended. Students may then cease to do any mathematics. The students in school E who have completed their IGCSE examination a year early continue with the additional mathematics syllabus. A grade C at IGCSE is the required level of mathematics attainment to continue to higher education. For this students need to achieve about 76% or higher on the core papers or 56% or higher on the extended papers. It is recommended that only those students with a grade B or higher will be able to manage the additional mathematics syllabus.

The IGCSE syllabus is differentiated between the two levels of entry. Mathematics after this level is optional. For these students to succeed at KCSE, they need to gain an A or B grade at 16+ and complete the additional syllabus. In analysing the KCSE syllabus for each year of secondary education it is seen that from form 1 there are topics which students entering the IGCSE core level will not cover. The students doing the core syllabus will not cover those topics that are entered under “Extended syllabus” or “Additional syllabus”. Similarly, those students doing the extended syllabus will not cover those topics that are entered under “Additional syllabus”. There will be another year for these students to cover these topics. Some topics have been omitted altogether from the English examinations.

IGCSE and additional mathematics students may use calculators. Formulae sheets are made available for the additional mathematics candidates but not for the IGCSE candidates. Students completing the core syllabus could attempt less than 25% of the KCSE papers, those completing the extended syllabus could attempt about 75%.
<table>
<thead>
<tr>
<th>Form 1</th>
<th>Extended syllabus</th>
<th>Additional syllabus</th>
<th>Not included</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Linear motion</td>
<td></td>
<td>Using mathematical tables</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dividing a line in a given proportion</td>
</tr>
<tr>
<td>Form 2</td>
<td>Equations of straight lines</td>
<td>Perpendicular lines and their gradients</td>
<td>Properties of congruent triangles</td>
</tr>
<tr>
<td></td>
<td>Fractional indices</td>
<td>Magnitude of vectors</td>
<td>Logarithm tables</td>
</tr>
<tr>
<td></td>
<td>Factorisation of quadratic expressions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solving linear inequalities graphically</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Angles in the same segment &amp; cyclic quadrilaterals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trig. formula for area of a triangle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Linear, area and volume scale factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form 3</td>
<td>Quadratic formula</td>
<td>Radian measure</td>
<td>Special curves</td>
</tr>
<tr>
<td></td>
<td>Sine and cosine rules</td>
<td>Surds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Matrices</td>
<td>Rules of logarithms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tree diagrams</td>
<td>Logarithmic equations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A.P.s and G.P.s</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vectors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Binomial expansion</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction to linear laws</td>
<td></td>
</tr>
<tr>
<td>Form 4</td>
<td>Matrix transformations</td>
<td>Calculating means using assumed mean</td>
<td>Navigation</td>
</tr>
<tr>
<td></td>
<td>Cumulative frequency curves</td>
<td>Variance &amp; standard deviation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time series and index numbers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trig. identities and trig. equations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Three dimensional geometry</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Differentiation and integration</td>
<td></td>
</tr>
</tbody>
</table>

Table 62: KCSE topics that are not included in the IGCSE core syllabus
References


Ainley, J. (1995) ‘Re-viewing graphing: traditional and intuitive approaches’ in Reader Block V, Chapter 7 (ME822), Milton Keynes, OU.


Campbell, I. (1996) quoted in 'Lessons' (various teachers' accounts of how they teach) in Reader Block III, Chapter 3 (ME822), Milton Keynes, OU.


Crook, J. and Briggs, M. (1991) 'Bags and Baggage' in Reader Block 1, Chapter 2 (ME822), Milton Keynes, OU.


Daily Nation (2000c) February 25, 2000, Nairobi

Daily Nation (2000d) February 26, 2000, Nairobi

Daily Nation (2000e) December 11, 2000, Nairobi

Denscombe, M. and Aubrook, L. (1992) “It’s Just Another Piece of
Schoolwork”: the ethics of questionnaire research on pupils in schools’, British


Force, London, DFEE.

Driver, G. (1980) ‘How West Indians do better at school (especially the girls)’,

Press.

Differential debilitation with peer and adult evaluators’, Developmental
Psychology, 12, 2, pp. 147-156.

Eales, A. (1986) ‘Girls and Mathematics at Oadby Beauchamp College’ in

teachers axed, p.1.


Hewitt, D. (1996) ‘Mathematical fluency: the nature of practice and the role of subordination’ in Reader Block VI, Chapter 4 (ME822), Milton Keynes, OU.


Keital, C. (1989) 'Mathematics education and technology' in Reader Block VI, Chapter 6, quoted in Study Guide, page 21 (ME822), Milton Keynes, OU.


Lee, L. and Wheeler, D. (1989) 'The arithmetic connection' in Reader Block II, Chapter 6 (ME822), Milton Keynes, OU.


Ruthven, K. (1990) ‘The influence of graphic calculator use on translation from graphic to symbolic forms’ in Reader Block V, Chapter 6 (ME822), Milton Keynes, OU.

Ruthven, K. (1995) ‘Pressing on’ in Reader Block V, Chapter 3 (ME822), Milton Keynes, OU.


Thompson, A. G. (1984) ‘The Relationship of Teachers’ Conceptions of Mathematics and Mathematics Teaching to Instructional Practice’ in Reader Block 1, Chapter 3 (ME822), Milton Keynes, OU.


Wilson, D. (1994) ‘The transference relation in teaching’ in Reader Block III, Chapter 9 (ME822), Milton Keynes, OU.

