TEACHERS' ATTRIBUTIONS AND BELIEFS ABOUT GIRLS, BOYS AND MATHEMATICS; A COMPARATIVE STUDY BASED ON 40 AFRIKAANS-SPEAKING SECONDARY MATHEMATICS TEACHERS IN THE WESTERN CAPE

A dissertation presented in partial fulfilment of the requirements for the Degree of

MASTER OF EDUCATION

Specialising in Mathematics Education

by
Rosina Catherina Roelofse
B.Sc., H.D.E., B.Ed.

at the

UNIVERSITY OF CAPE TOWN

Supervisors: Paula Ensor, Prof. J. Meyer

February 1998

DECLARATION

I, Rosina Catherina Roelofse, declare that this work is my own original work and that it has not been submitted to any other institution before for assessment purposes. I have acknowledged all sources used and have cited these in the Bibliography.

signature removed

Signed by candidate

Signature

9.03.98

Date

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to the following:

Paula Ensor for her excellent supervision, patience, encouragement and help in the preparation of this dissertation.

Prof. Erik Meyer for his excellent supervision, constructive criticism and expert advice.

All the **teachers** that participated in the present study.

Ronélle Mouton for believing in me and her love, encouragement and support.

My friends and family for their continuous support and love.

The financial assistance of the **Centre for Science Development** (HSRC, South Africa) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the author and not necessarily to be attributed to the Centre for Science Development.

ABSTRACT

This dissertation is concerned with teachers' beliefs regarding boys, girls and mathematics. The present study is a partial replication of a study conducted by Fennema et al (1990) and the results are compared. The present study extended the work of Fennema et al (1990) through an exploration of the structure of the data. Forty female teachers in the Western Cape region were interviewed. They were asked to identify their two most and least successful boys and girls in mathematics and to attribute causation for success and failure. They were also asked to respond to 20 characteristics on a "Likert type" response format. The results generated from the present study concluded that teachers believed their female students to be their more successful mathematics students. They attributed the most successful girls' achievement mainly to effort whereas with the most successful boys, achievement was attributed to ability and effort. Both the most successful boys and girls failures on mathematics tasks were attributed to the difficulty of the task. Achievement of the least successful girls was attributed mainly to teacher's help and for the boys it was attributed to teacher's help and task. For both these groups, ability and to a lesser extent, effort, are given as the main reasons for failure on mathematics tasks. Very little difference was found between teachers' responses regarding the characteristics of their best boy and best girl mathematics students. When exploratory factor-analysis was performed a difference was found in the factor-solutions for the boys and the girls. This study suggests that there might be a difference in teachers' beliefs regarding boys and girls achievement in mathematics that is worthy of further exploration.

LIST OF CONTENTS

	Page
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: LITERATURE SURVEY	3
2.1 Introduction	3
2.2 The autonomous learning behaviour model	5
2.3 Teachers' practices and beliefs with respect to gender differences and mathematics	7
2.3.1 Teachers' practices.....	7
2.3.2 Teachers' beliefs	9
CHAPTER 3: THE FENNEMA STUDY	16
3.1 Selection of the most/least successful students and attributions for success and failure	18
3.2 Sex-Role Stereotype Questionnaire	20
3.3 The three-part test	22
3.4 The results	23
CHAPTER 4: RESEARCH DESIGN AND DATA COLLECTION	29
4.1 The initial research design of the present study	29
4.2 Data gathering instrument	31
4.3 Pilot study	33
4.4 Change in the research design	35
4.5 Operationalisation	36
4.6 Statistical analysis.....	37
CHAPTER 5: ANALYSIS AND DISCUSSION OF THE DATA	39
5.1 Interview data	39
5.2 Most and least successful students	40
5.3 Attributions	44
5.4 Adjective checklist	50
5.4.1 T-test analysis.....	50
5.4.2 Exploratory factor-analysis	55
5.4.3 Comparison of the factor-solutions	58
5.4.4 Item-correlation analysis	59
CHAPTER 6: COMPARISON AND CONCLUSION.....	63
6.1 Comparison and discussion	63
6.2 Implications and limitations of the present study	71

BIBLIOGRAPHY 75

APPENDIX I: RAW DATA OF TEACHERS' RESPONSES 83

APPENDIX II: BOYS ATTRIBUTIONS AND CHARACTERISTICS 85

APPENDIX III: GIRLS ATTRIBUTIONS AND CHARACTERISTICS 87

APPENDIX IV: AFRIKAANSE VRAELYS 89

APPENDIX V: ENGLISH QUESTIONNAIRE 96

APPENDIX VI: THE FENNEMA ET AL (1990) ARTICLE 103

CHAPTER 1

INTRODUCTION

Over the past two decades a considerable literature has been generated on the topic of "boys, girls and mathematics". Girls have become the focus of research interest in mathematics education on the basis of their apparent under-performance in mathematics examinations, their more negative personal belief systems about mathematics, their relatively low enrolment for mathematics courses at a higher level and their under-representation in science and engineering professions (Fennema, 1987; Shuard, 1986). However, there is still very little information specifically about teachers' beliefs about boys, girls and mathematics, to what causes they attribute differences in performance and the influence of these beliefs on reproducing gender differences. Therefore, the focus of this dissertation is not on gender differences in mathematics performance as such, but rather on *teachers' beliefs* regarding boys, girls and mathematics and how these beliefs might contribute to differentiated performance.

Considering the limitations in our current knowledge on teachers' beliefs about boys, girls and mathematics and the fact that the South African circumstances differ considerably from those in the United States, it was decided to conduct a partial replication study of a study by Fennema et al (1990) (see Appendix VI) and to compare the results. The present study will also seek to extend the work done by Fennema et al (1990) through exploratory factor-analysis.

Chapter 2 of the present study reviews the literature concerning firstly, gender differences in mathematics achievement and secondly, teachers' practices and beliefs with respect to gender differences and mathematics.

Chapter 3 is an in-depth discussion of the study carried out by Fennema et al (1990), their methods as well as their findings. Their study forms the basis of the present study.

Chapter 4 discusses the methodological approach of the present study. The original plan as well as the changes that were made in the course of the present study will be discussed.

Chapter 5 highlights the results of the present study. The data is analysed and discussed and an extension to the work of Fennema et al (1990) is brought to the foreground. The addition of exploratory factor-analysis adds a new dimension to the analysis of the results.

Chapter 6 compares the findings of the present study to those of Fennema et al (1990). Interpretations of the similarities and differences are made and conclusions drawn.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1. Introduction

The purpose of this chapter is to consider previous research in the area of gender and mathematics and to lay the basis for a discussion of the objectives and methodology of the present study. This review is concerned both with teachers' beliefs regarding boys, girls and mathematics, and the theoretical framework in which much of the work on gender and mathematics has been conducted.

Gender differences in mathematics are a complex issue which can be explored from different angles and perspectives. A popular interest in gender differences in mathematics was reflected in, for example, the widely published articles of Benbow and Stanley in the 1980's (1980, 1981, 1983a and 1983b) and articles published in many popular magazines, for example, a report in TIME Magazine (1982, p.64) suggested "it is well known that teenage boys tend to do better at math than girls..". Following this, many researchers have become concerned with the media portrayal of girls' performance in mathematics.

Gender differences in mathematics achievement has become a concern because of more negative personal belief systems about mathematics by girls, relatively low enrolment for mathematics courses at a higher level by girls and in superior performance by boys in higher cognitive level mathematics tasks (Fennema, 1987; Shuard,

1986). A considerable literature has been generated in the area of gender and mathematics. Nevertheless, there is still very little information specifically regarding teachers' attributions and beliefs about boys, girls and mathematics and the influence of these beliefs on gender differences.

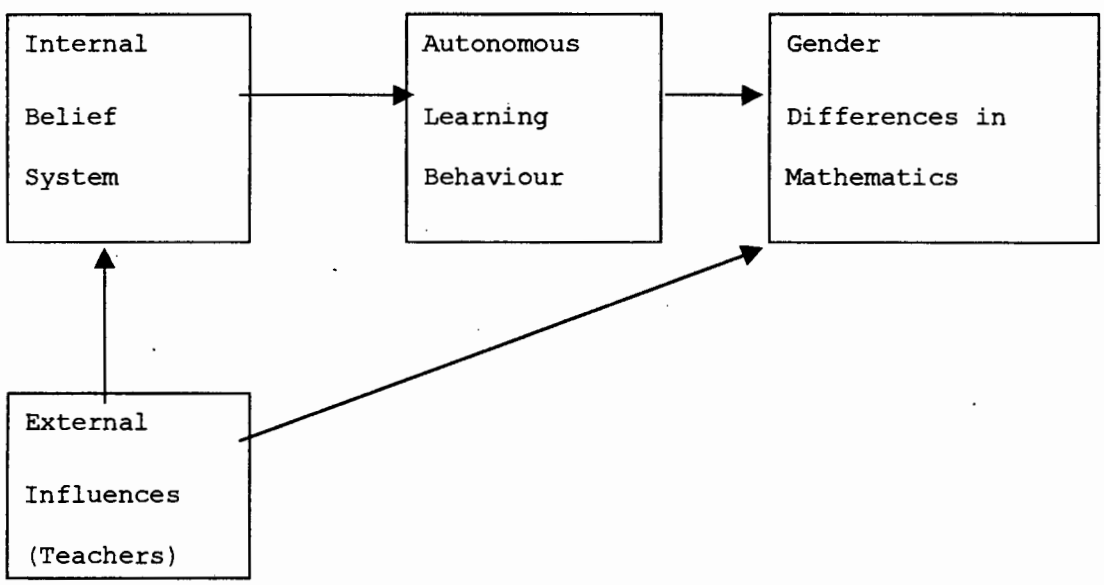
Over the past few decades, researchers have attempted to isolate those cognitive skills and processes which might contribute to mathematics achievement. Both verbal and spatial skills have been cited consistently as cognitive variables that might help explain gender-related differences in mathematics achievement (Aitken, 1971; Tartre, 1990).

The relationship between affective variables and mathematics achievement has also been studied: Fennema and Sherman (1977), as well as Meyer and Koehler (1990), found that confidence in learning mathematics correlates strongly with mathematics achievement. Other affective variables identified were attitude to success in mathematics, stereotyping of mathematics as a male domain, perceptions about the usefulness of mathematics and whether or not the student enjoys learning mathematics (Fennema and Sherman, 1977). Another affective variable, which has been considered important by Fennema and Sherman (1977) and has special importance for this dissertation, is the perceived role of the teacher in the learning of mathematics. These affective variables are interwoven and Fennema and Peterson (1985) attempt to link them through the development of their autonomous learning behaviour model.

2.2 The autonomous learning behaviour model

The Autonomous Learning Behaviour (ALB) model was proposed by Fennema and Peterson (1985) as an attempt to explain causation of gender differences in mathematics. Through this model, Fennema and Peterson (1985) attempt to go beyond the ability, potential and attitude of individual students to take account also of external ~~societal~~ classroom influences. The variable considered most important by Fennema and Peterson (1985) is classroom interaction. The *influence* of teachers on both students' internal motivational beliefs (for example, perceived usefulness of mathematics, confidence and *the attribution of success and failure* in mathematics) and on autonomous learning behaviours (for example students' participation in the classroom and their ability to work independently, persist and succeed at tasks) form one component of the external influences which might play a role in the development of gender differences.

Figure 1: Autonomous Learning Behaviour Model



From: Fennema,E., Peterson,L., Carpenter, T. P. & Lubinski, C. A. (1990). Teachers' attributions and beliefs about Girls, Boys and Mathematics. *Educational Studies in Mathematics, 21,* 55 - 69.

For the development of the ALB model, mathematics tasks of high cognitive complexity were chosen. This was done firstly because gender differences were argued to be more apparent at this level and, secondly, because skill on high level tasks is associated with problem solving, a major goal of mathematics learning. According to the ALB model, gender differences on mathematics tasks of high cognitive complexity are the result of different participation of boys and girls in autonomous learning behaviours.

> Male superiority in mathematics is found especially in performance on tasks of high cognitive complexity such as true problem solving (Fennema, 1981). To do tasks of such complexity, one must be able to work independently, persist, choose, and succeed at such tasks. These behaviours, autonomous learning behaviours (ALB), are hypothesized to serve as mediators between internal/external influences and mathematics performance in tasks of high cognitive complexity where sex-related differences in mathematics are found (Fennema & Peterson,1985: p.309).

Autonomous students are those who take control of their own learning. This includes those students who prefer to work independently and choose to engage in high-level mathematics tasks. Furthermore, autonomous students persist with difficult, high-level mathematical problems. This results in success in mathematics that strengthens the student's internal belief system (for example confidence and usefulness of mathematics). It seems clear that greater participation in autonomous learning behaviours enhances achievement in high-level mathematical tasks. According to Fennema and Peterson (1985), girls are *less likely* to develop autonomous learning behaviours (for example, independence,

persistence and choosing to engage in high-level mathematics tasks).

The ALB model postulates that participation in autonomous learning behaviour mediates the relationship between affect (internal beliefs), teachers and outcomes (including mathematics achievement) (Fennema, 1985). The ALB model itself does not explain exactly how teachers make their attributions, but lays the basis for further work by Fennema et al (1990). Teachers' influences on students' internal beliefs and on participation in autonomous learning behaviour include "the beliefs and expectations held by the teacher, the things the teacher says and does and the activities in which learners are expected and encouraged to participate" (Friedman, 1989, p.213).

2.3. Teachers' practices and beliefs with respect to gender and mathematics.

Teachers are a crucial educational influence on students' learning of mathematics, through their mediation of educational policies, texts and physical context.

2.3.1. Teachers' practices

Various components of the school system have been investigated as contributing to gender differences, for example stereotypes in textbooks (Northam, 1986), structure and organization of classrooms (Hallinan and Sorenson, 1987) and interaction between teacher and students during mathematics lessons (Leder, 1987). In contrast studies such as the British Assessment of

Performance Unit (APU) study conducted over a 5 year period, have shown that gender differences in mathematics performance were greater between different regions of Great Britain and between schools with a high and low percentage free school meals. This again emphases the important role the schools play in gender differences in mathematics.

Nevertheless inevitably schools play a role in the development of sex-role standards and sexually stereotypic behaviour. Minuchin (1971) found that the "sex-role behaviour" of children attending "schools categorized as traditional differed in their sex-typed reactions from those who attended schools categorized as modern" (p.89). In traditional schools the boys were leaders in problem solving while the girls became followers. This was not the case in less traditional schools.

Teacher-learner interaction has been the focus of much research regarding gender differences in mathematics. Research on classroom organization has shown the importance of monitoring the gender composition of groups organized in classrooms in order for all students to gain the attention, help and explanation required (Webb and Kenderski, 1985). Studies on ability grouping for instruction have found that girls who are strong in mathematics are less likely to be assigned to high-ability groups than boys who are strong in mathematics and that high achieving girl students are more often assigned inappropriately to lower ability groups (Hallinan and Sorenson, 1987).

Differential treatment studies have shown that teachers often interact differently with their male and female students (Stallings, 1979; Becker, 1981). Studies have shown that teachers interact more with boys than with girls (Leder, 1990; Koehler,1990). Teachers interact more with high mathematics achieving boys, who also receive more praise and discipline than girls do. Girls, on the other hand, are encouraged by teachers to be dependent rather than independent in mathematics. Although girls receive less help, they spend more time helping others than boys do. Thus, boys receive more and qualitatively different attention from teachers (Leder, 1990; Koehler, 1990; Fennema and Peterson, 1985).

Teachers engage in making pedagogic decisions in the classroom environment, while interacting with students. Teachers are required to make decisions on how to motivate students, how and when to take disciplinary measures, the pace of work, how and to whom questions are asked, how to respond to answers and so forth. Teachers' decisions affect what students learn, but also how they feel about themselves when learning. These decisions reflect teachers' beliefs (Fennema, 1990).

2.3.2. Teachers' beliefs

In a discussion based partly on empirical findings from research studies on teachers' beliefs, Ernest (1988) extracted three key elements that influence teachers' practices of mathematics teaching:

1. The teacher's mental contents or schemas, particularly the system of beliefs concerning mathematics and its teaching and learning;

2. The social context of the teaching situation, particularly the constraints and opportunities it provides; and,
3. The teacher's level of thought processes and reflection. (p.1)

Ernest (1988) argued that studies on the beliefs of mathematics teachers indicate that teachers' approaches to mathematics teaching depend on their beliefs. Thompson argued that:

> Teachers' conceptions of mathematics teaching are also likely to reflect their views, though tacit, of students' mathematical knowledge, of how they learn mathematics, and of the roles and purposes of schools in general (Thompson, 1992, p.135).

What is the meaning of the term "belief"? Nespor (1987, p.321) argues that "belief systems often include affective feelings and evaluations, vivid memories of personal experiences, and assumptions about the existence of entities and alternative worlds, all of which are simply not open to outside evaluation or critical examination in the same sense that the components of knowledge systems are".

Because of the close connection between "beliefs" and "knowledge" it is difficult to clearly distinguish between the terms (Scheffler, 1965). Some distinctive features of beliefs are that they can be held with varying degrees of conviction and are not consensual (Abelson, 1979). Truth and certainty are associated with knowledge, while disputability is associated with beliefs (Thompson, 1992). Characteristics of knowledge are general agreement and satisfaction of a truth condition. Beliefs, on the other hand, are independent of their validity and are characterized by lack of agreement over how they are to be evaluated (Thompson, 1992).

Thompson concluded that:

> Studies of the relationship between teachers' beliefs and practice lead us to question the adequacy of two related assumptions underlying a number of studies. One of them is that belief systems are static entities to be uncovered. The second assumption is that the relationship between beliefs and practice is a simple linear-causal one. Thoughtful analysis of the nature of the relationship between beliefs and practice suggest that belief systems are dynamic, permeable mental structures, susceptible to change in light of experience. The research also strongly suggests that the relationship between beliefs and practice is a dialectic, not a simple cause-and-effect relationship (Thompson,1992, p.140).

Clark and Peterson (1986) published a comprehensive review of teachers' thought processes, namely teachers' perception of the causes of students' behaviour. When a teacher believes that he/she has some control over a student's learning, the teacher feels greater responsibility for student learning (Guskey, 1982). Clark and Peterson (1986) concluded that teachers have a *personally held system of beliefs* that influences their attitude, behaviour, plans and actions in classrooms. In other words, they argue that teachers' beliefs shape teachers' practice.

Teachers' beliefs are thus identified as an important influence on the development of gender differences in mathematics. A number of researchers have investigated teachers' attributions of causality for the success and failure of their students (Weiner, 1974; Bar-Tal and Guttmann, 1981; Clark and Peterson, 1986). Teachers may attribute students' achievements to students themselves (ability, effort, motivation, independence etc.); teachers (their own knowledge, ability, motivation etc.)

or external causes (easiness or difficulty of task, luck etc.). Many of these attribution studies are based on the work of Weiner (1974) who classifies the dimensions of stability and locus of control. According to this classification some causes are stable over time (for example task and ability) and others are unstable and subject to possible change, such as effort and environment. The personal explanations of causality fall into four categories (fig.2): ability, effort, task difficulty, or luck. These four categories are derived from two factors with two levels each: firstly locus of causation (internal/external) and secondly degree of stability (stable/unstable).

FIGURE 2: WIENER CLASSIFICATION

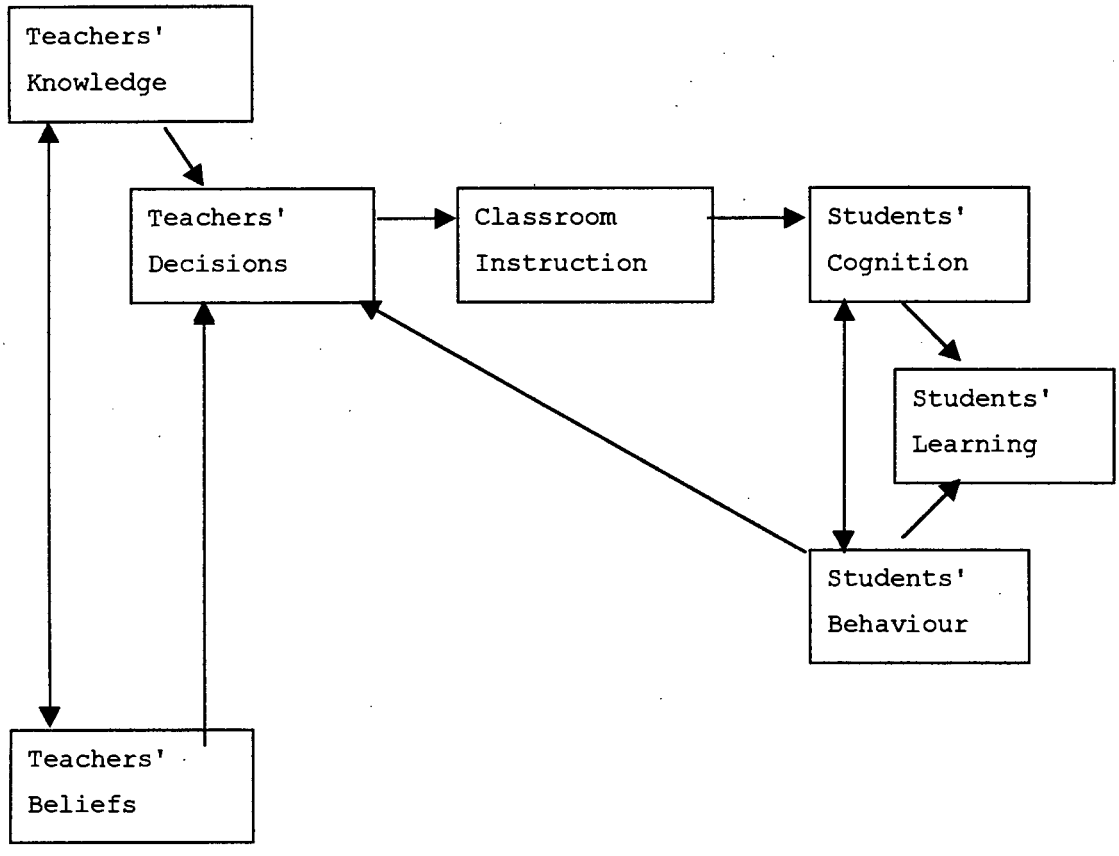
		LOCUS OF CAUSATION	
		Internal	**External**
DEGREE OF STABILITY	**Stable**	Ability	Task
	Unstable	Effort	Luck

From: Wiener, B. (1974). *Achievement Motivation and Attribution Theory*. Morristown, New York: General Learning Press.

Wiener's attribution theory predicts that performance that is consistent with teachers' expectations will be attributed to a stable cause, whereas outcomes contrary to expectations will be attributed to unstable causes. These attributions hold whether the outcome is success or failure. Although Wiener (1974) did not emphasize gender differences the validity of this scheme for understanding gender differences in teachers' expectations of their students is well recognized (Clark and Peterson, 1986; Peterson and Barger, 1985; Fennema, 1990).

Fennema, Carpenter and Peterson (1991) put forward a further model building on the work described here with respect to the ALB model which suggests that students' learning is influenced by teachers' knowledge and beliefs (Fig 3). According to this model, students' cognitions and behaviours have a direct influence on students' learning. The knowledge and beliefs of teachers affect their decisions which in turn influence classroom instruction, which plays an important role in students' cognitions and behaviours.

Figure 3: The influence of teachers' knowledge and beliefs on students' learning.



From: Fennema, E. (1990) Teachers' Beliefs and Gender Differences in Mathematics in Fennema, E. and Leder, G. C. (Eds.) *Mathematics and Gender*. Teachers' College Press, New York.

Fennema (1990) suggested that one could substitute "gender differences in mathematics" for "students' learning" in the last box of the model. Thus, teachers make decisions about what boys and girls should do in the classroom, which is based on teachers' knowledge and beliefs about gender differences in mathematics.

Various other explanatory models have also been put forward to explain gender differences in mathematics: some argue that innate biological factors (for example visual-spatial abilities) explain the differences (Benbow, 1988) while others regarded environmental causes as the most important (Peters, 1991). However, there are many problems attached to all these models used to explain gender differences in mathematics. Macleod comments as follows:

> Firstly, it is taken for granted that 'differences' is a legitimate site for investigation. When studying differences, the notion of measurement and comparison come into play. When the starting point is a western-patrocentric norm of performance in mathematics, the study of differences becomes very powerful in legitimating those exact norms. Secondly, studies of this nature, whether feminist or not, remain trapped within the same categories (the reifying dualisms of girls versus boys, individual versus society, same versus different) and within the same terms (the statistical search for differences or lack thereof). Thirdly, the models tend to pathologize the performance of girls and suggest that all will be righted should such-and-such be done (more girls be encouraged to enrol in higher mathematics courses, mathematics not to be stereotyped as a male domain). Fourthly, the nature of mathematics itself is treated unquestioningly as timeless and universal. These models bypass the embeddedness of

> mathematics as a discourse within the social and historical production of power relations and gender differences (Macleod, 1995, p.191).

Most studies dealing directly with teachers attributions and beliefs have not included gender as a variable (Fennema et al, 1990). Thus although much has been written on teachers' beliefs, less is known about their beliefs in relation to gender and mathematics. Fennema et al (1990) investigated teachers' attributions and beliefs about boys, girls and mathematics amongst first-grade female teachers in 24 schools in the United States. They focussed on teachers' identification of most and least successful mathematics students as well as the accuracy of the teachers' identification. Furthermore, teachers' attributions of the causes of successes and failures of boys and girls, and teachers' beliefs about the characteristics of their best girl and boy mathematics student were also investigated.

For the purpose of the present study, work in the field of "teachers' beliefs on boys, girls and mathematics" will be approached through an investigation of the work of Elizabeth Fennema. This dissertation is a partial replication study of a research project published by Fennema et al, 1990. This study by Fennema et al (1990) as well as the reasons for, and design of, the present study are discussed in detail in the next chapter.

CHAPTER 3

THE FENNEMA STUDY

This chapter sets out the framework in terms of which the present study was undertaken. The research question is whether teachers hold different beliefs regarding boys, girls and mathematics, and attribute their success and failure differently. This research project is comparative to the study done by Fennema et al (1990). The reason for the Fennema et al (1990) study, the way in which they conducted their research, as well as their results will be discussed in this chapter.

Studies about teachers' beliefs about boys, girls and mathematics have investigated different areas, such as: teachers' general conception of their roles (Janesicki, 1977); their general beliefs about the curriculum (Bussis, Chittenden and Amarel, 1976) and the general principles used to explain their own interactive behaviour (Connors, 1987).

Fennema et al (1990) argued that teachers' beliefs in relation to gender and mathematics were under-researched and therefore decided to conduct a study on teachers' attributions and beliefs in relation to gender and mathematics. They argue that teachers' beliefs are important and that very little is known about teachers' attributions and beliefs about, boys, girls and mathematics and the influence of these beliefs on teachers' behaviour, and attitudes, towards their male and female students.

Fennema et al (1990) based their study on 38 first grade *female* teachers in 24 schools in the U.S., in other words a gender-biased sample of teachers. The mean number of years of teaching elementary school in this sample was 10,9 and the mean number of years teaching the first grade was 5,6. The total number of students who were the subjects of the study, comprised 368 boys and 314 girls. The number of students in a class group varied in size from 6 to 27. Some of the classes consisted of a combined first and second grade group. Fennema et al (1990) were interested in teachers' beliefs about these first grade students.

Fennema et al (1990) structured their study by addressing the following questions:

(1) Which gender do teachers believe their most and least successful students to be?
(2) How accurate are such teachers' beliefs?
(3) Do teachers attribute causation for success and failure differently for boys and girls?
(4) Do teachers believe that there are differences in the characteristics of their best boy and best girl mathematics student?

Information appropriate to teachers' beliefs about successful and unsuccessful students and attribution of causation of success and failure was gathered in a structured, individual interview, by a trained interviewer, towards the end of an academic year.

In conducting the interviews teachers were asked to:

- identify their two most and least successful boys and girls in mathematics,

- attribute causation for these students' success and failure and
- describe the characteristics of their best male and best female student.

The format of the interviews will now be discussed in the following paragraphs as well as the results generated from the responses of the teachers.

3.1 Selection of most/least successful students and attributions for success and failure

Teachers were firstly asked to name the *most* successful mathematics student in their class. No reference was made to gender. A list of attribution categories, as shown in Table 3.1, was then shown to the teacher concerned who was then asked to select the *major reason* why the student she selected succeeded in learning mathematical concepts. She was also asked to select the *major reason* why she thought that particular student had trouble learning mathematical concepts. It is necessary to stress that even the best students will sometimes have difficulty in learning mathematical concepts. In the context of the Fennema study "failure" in the attribution list means "difficulty" in learning mathematical concepts.

After the selection of her most successful mathematics student the teacher was asked to select her *second most* successful mathematics student. Again, no reference was made to gender. She was then asked to respond to the same set of questions regarding success and failure in the learning of mathematical concepts.

TABLE 3.1: List of Attributions

ATTRIBUTIONS			
Success		Failure	
1	Ability	1	Lack of ability
2	Effort	2	Lack of effort
3	Intrinsic motivation	3	Lack of intrinsic motivation
4	Easiness of the task	4	Difficulty of the task
5	Teacher help	5	Lack of help from teacher
6	Others help	6	Lack of help from others
7	Other causes	7	Other causes

After the teacher had selected and responded to the two most successful mathematics students in her class, the interviewer asked two more sets of questions so that every teacher responded in respect of attributions for the *two most successful girls and the two most successful boys* in their class. Exactly how the interviewers went about doing this is not explained by Fennema et al (1990).

The teachers were then similarly asked to name their *least* successful and *second least* successful mathematics student, with no reference to gender. They also had to respond to the list of attribution categories and selected the *major reason* for success and failure by these students. Although such "least successful" students find mathematics a very difficult subject, they sometimes do understand mathematical concepts.

Once again, the interviewers asked questions in such a way that the teachers ultimately named two boys and two girls as their least successful mathematics students.

Thus, at the conclusion of the attribution interview, each teacher had selected and responded in respect of eight students, namely, four boys and four girls.

3.2 Sex-Role Stereotype Questionnaire

The next step in the gathering of information about teachers' beliefs was concerned with the *characteristics* of their best boy and best girl mathematics student. This information was collected by using a questionnaire that was an adaptation of the Broverman et al (1970) Sex-Role Stereotype Questionnaire. The original questionnaire, constructed by Broverman et al (1970), has 122 bipolar items each of which describes, with an adjective or a short phrase, a particular behaviour or characteristic; for example, very emotional / not at all emotional.

Table 3.2 contains twenty descriptors regarding the characteristics of the best boy and best girl mathematics student, as selected by Fennema et al (1990) for their study. They used sixteen descriptors, selected from the 122 bipolar items in the Broverman et al (1970) Questionnaire which, in their view, were relevant to mathematical behaviour. Four descriptors were added because of their direct relationship to classroom mathematical behaviour. These four descriptors can be seen in table 3.2 from number 17 to 20.

In respect of the best boy and best girl students, the 38 female teachers in the Fennema study were asked to respond to each of the twenty items, as set out in table 3.2, on what they referred to as a "Likert scale" (p.60). A Likert scale consists of a number of statements; some positive and some negative, relating to the charac-

teristic being measured. The response on each statement is placed on a five point scale from strongly disagree at one end to strongly agree at the other end of the scale. The options of strongly disagree, disagree, neutral, agree and strongly agree are captured on a 1 to 5 numerical range.

TABLE 3.2: Adjective checklist

1	Not aggressive	Very aggressive
2	Not independent	Very independent
3	Very subjective	Very objective
4	Very easily influenced	Not easily influenced
5	Very submissive	Very dominant
6	Very passive	Very active
7	Not at all competitive	Very competitive
8	Very illogical	Very logical
9	Very indirect	Very direct
10	Not at all adventurous	Very adventurous
11	Very quiet	Very loud
12	Has difficulty making decisions	Makes decisions easily
13	Almost never acts as leader	Almost always acts as leader
14	Very strong need for security	Very little need for security
15	Not at all self-confident	Very self-confident
16	Very uncomfortable about being aggressive	Not uncomfortable about being aggressive
17	Seldom volunteers answers to mathematics problems	Often volunteers answers to mathematics problems
18	Does not enjoy mathematics very much	Enjoys mathematics very much
19	Very dependent in mathematics	Very independent in mathematics
20	Does not persist on hard mathematics tasks	Very persistent on hard mathematics tasks

The scale Fennema et al (1990) used consisted of twenty statements, each with a positive and negative pole. They were arranged with the negatively worded statement on the left and the positively worded statement on the right and a scale of 1 to 5 in between. A score of 1 meant that the teacher had a high agreement with the negatively worded statement and 5 meant a high agreement with the positively worded statement. This kind of scale was used to enable the teachers to give a more accurate rating of their beliefs about their best boy mathematics student and best girl mathematics student. The teachers' responses captured on the scale of 1 to 5 furthermore assisted in a more accurate comparison between data, regarding the teachers' beliefs about their students. A comparison was then made between the responses of the teachers' beliefs about the characteristics of their best boy and best girl mathematics student.

The last section of the gathering of information concerned the writing of a three-part test by all the students to measure mathematics achievement, as well as to determine the accuracy of the teachers' selections.

3.3 The three-part test

In order to judge the accuracy (or validity) of their selection of the most and least successful students, a group administered three-part test was given to all the students in the Fennema study. The three-part test consisted of

(1) a Fact test, comprising 20 addition and subtraction basic number facts, to be completed in two minutes.

(2) a "Problem Solving-Regular" test that included nine addition and subtraction word problems over a range of problem types

(3) a "Problem Solving-Extension" test consisting of four problems involving several operations or extraneous numbers and four problems involving grouping and partitioning. These problems were all printed on separate pages and were read to the students by a trained tester. They were also instructed when to turn the page.

The number of correct responses on the different parts of the test was added to give the achievement score of each student. These scores were listed by gender and test. Fennema et al (1990) used the test in order to try and establish the *validity* of the teachers' selections for their two most successful and two least successful students. The extent to which they were able to do so will be addressed under the discussion of their findings.

3.4 The results

A t-test was performed on the results of the three-part test. They found statistically non-significant differences in the performance of the boys and girls on the Fact-test and the "Problem Solving-Regular" test. The boys scored significantly higher on the "Problem Solving-Extension" test and Fennema et al (1990) argued that this test "probably did not reflect direct instruction by the teacher and may have required more autonomous learning by the students" (p.61).

The selection by the teachers concerning their beliefs about their two *most successful* students with their *free choice*, led to the following results:

(1) 8% of the teachers chose no boy during their free selection of their two most successful mathematics students

(2) 45% of the teachers chose no girl during their free selection of their two most successful mathematics students

(3) the frequency with which a boy was selected as the most successful mathematics student expressed as a percentage was 79% and

(4) as second most successful student 58%

In selecting the two *least successful* students, the responses of the teachers were as follows:

(1) 82% of the responses included "at least" (p.61) one boy

(2) 61% of the responses included "at least" (p.61) one girl

Questions that can be raised are: How many selections did not include any boys? How many selections did not include any girls? What was the frequency (expressed as a percentage) with which a girl/boy was selected first as the least successful student? These questions point to omissions of disclosure in the original Fennema study.

Fennema et al (1990) also argued that "boys tend to be chosen more often as both most and least successful mathematics students" (p.61) but gender difference was not apparent in the selection of the least successful mathematics students.

In order to determine the accuracy of the teachers' selections, they considered the two highest scores achieved by each group in the three-part test. If the student that teachers selected as one of the two most successful students achieved one of the two highest scores, it counted towards an accurate choice. This applied to the two lowest scores achieved by every group. If the student that teachers selected as one of their two least successful students achieved one of the lowest marks it similarly counted as an accurate choice.

From the information gathered, more than half of the selections made by the teachers regarding her most successful and least successful mathematics students were "accurate" (p.61) (68 out of a possible 126). Unfortunately the "accurate" (p.61) responses regarding the boys and girls were *not given as separate values*. The "inaccurate choices" (p.61) are listed in terms of the most successful and least successful mathematics students. The teachers' "inaccurate choices" regarding the girls consisted of 10 least successful students and 13 most successful students. The selection of a boy as the most successful mathematics student resulted in 24 "inaccurate choices" and those of a boy as the least successful student in 11 "inaccurate choices". According to Fennema et al (1990), "teachers were most inaccurate when selecting the most successful boy" (p.55).

Missing data has an effect on determining the validity of teachers' choices. Although 38 teachers took part in the study, one teacher's data was completely missing regarding this particular section, and 22 other data values were missing out of a possible 148 selections. This represents almost 15% of the total number of

responses. The 22 missing data were not explained in terms of the category they was missing from; most successful, second most successful, least successful or second least successful. They do not point to the implications of this missing data for the interpretation of results.

The accuracy of the teachers' choices are given as a frequency while their selection of most and least successful students are expressed as a percentage. In order to establish the ratio of accurate: inaccurate in each of the categories, both should be expressed as a frequency. There is a possibility that the teachers were more "inaccurate" in their selection of the girls if fewer girls than boys were selected as one of the two most successful mathematics students. Unfortunately, it is not possible to explore this possibility further because the raw selection data are not presented in the Fennema study.

Fennema et al (1990) listed teachers' attributions for success and failure in the various categories of most successful and least successful students. The results were expressed as a percentage and they had one missing data value. They established that the most important attribution for success for the most successful girls were ability (33%) and effort (37%), while ability (58%) was found to be the most important reason for success for the most successful boys. The reasons for failure of the most successful girls/boys were attributed to task (40%/45%). They argued that differences between teachers' attributions for the most successful boys' and girls' failure appeared *minimal* with the exception of task. They also make a valid point in stating that teachers seldom

see lack of ability as the reason for failure by their best boy and girl mathematics student.

Differences appeared in the attributions teachers made for success and failure of their least successful mathematics students. The least successful girls' successes were mainly attributed to effort (32%), and teacher help (24%), while for the boys they were attributed to effort (24%), teacher help (35%), and task (16%). The attributions for failure of the least successful boys and girls were high in the same categories. The highest scores for the girls/ boys were lack of ability (29%/22%), lack of effort (28%/33%) and task (28%/20%). A comparison between results of the teachers' attributions from the study done by Fennema et al (1990) and the present study will be made in Chapter 6.

Fennema et al (1990) used an adjective checklist to test teachers' beliefs about the *difference in characteristics* of their best girl and best boy mathematics student; t-tests were performed on teachers' responses on each of the phrases of adjective checklist. Teachers gave significantly higher ratings for boys compared to girls on the following: *competitive, logical* and *adventurous* with p-values < 0.05, while the following statements represent a p-value < 0.01: *volunteering answers to mathematical problems, enjoyment of mathematics* and *independence in mathematics.*

After an evaluation of all their results Fennema et al (1990) concluded that:

(1) Teachers' beliefs about and attributions for first-grade mathematics students are different

(2) Teachers perceived boys to be their best students
(3) Teachers attributed causes for success and failure differently for boys and girls
(4) The way in which attributions for girls were made are widely believed to have a negative impact on their achievement
(5) Teachers' believed that boys exhibit more autonomous learning behaviours
(6) Teachers' perceptions were that boys showed stronger characteristics than girls did, although the boys and girls showed similar characteristics

Fennema et al (1990) came to the conclusion that "it appears that teachers' knowledge about gender differences which existed had not eliminated inequities in mathematics" (p.66) and that the teachers used in their study held different beliefs about boys, girls and mathematical achievement. They also argued that these beliefs could be seen as an influence on the development of gender differences in mathematics.

A comparison of the findings of Fennema et al (1990) and the present study will be discussed in Chapter 6. The methodology of the present study in relation to that adopted by Fennema et al (1990) will be discussed in the following chapter.

CHAPTER 4

RESEARCH DESIGN AND DATA COLLECTION

4.1 The initial research design of the present study

In looking back at the Fennema et al (1990) study the intention was to conduct a *comparative* study and perhaps extend the study in respect of the gender of teachers, particularly given the female gender of the respondents used by Fennema et al (1990). This intention gave rise to what will now be referred to as the "initial" research design of the present study.

Fennema et al (1990) conducted their study in the United States of America. Considering the fact that South African circumstances differ considerably from those in the United States, it was felt that a comparative study would make a contribution towards mathematics education in South Africa where significant educational changes are taking place.

The present study was initially intended as a comparative study, based on the Fennema et al (1990) study, but using 20 male and 20 female teachers. In order to minimise sources of variation attributable (in the South African context) to language and schooling "model", the subjects of this study were to be chosen from Afrikaans teachers in ex-"Model C" schools. Variation of attribution by these teachers across standards was to be addressed by confining attribution interviews to grade 9 students only.

The present study, as initially planned, thus differed from the Fennema et al (1990) study in three respects:

(a) the students would all be grade 9 (14 years old) students.

(b) the students would not be given the group administered three-part test.

(c) both male and female teachers would form the subjects of the study.

Fennema et al (1990) said very little about the reliability and validity of their measures. They indicate that an independent measure of "validity" is provided by the test results insofar as these reflect an "objective" source of ranking of the two best and two worst mathematics students that can be compared to teachers attributions. They used a three-part test (described in chapter 3) in an attempt to provide an "objective" measure of student achievement in mathematics. This procedure raises a number of problems. First of all, it is not demonstrated by Fennema et al (1990) that this three-part test was a valid test of achievement. Did the grade 1 teachers in whose classrooms these tests were conducted, for example, establish "face" validity for these instruments? It would have been difficult and time-consuming for me to design a standardized achievement test for all grade 9 students which had face validity for all the teachers in my sample.

Furthermore, a deeper question is raised by the use of the test. The Fennema design draws a distinction between teachers' attributions on the one hand and students' performance on the test on the other and suggests that the latter is a "true" measure of achievement. My argument is that teachers' attributions are based on a

range of factors; achievement in tests, assignments, projects, classroom interaction, behaviour and so on. These attributions are of interest in terms of their impact in classrooms. It is of less concern whether student's performance and ranking on tests is different to teachers' ranking.

4.2 Data gathering instrument

An attempt was made to contact Elizabeth Fennema to obtain the original instruments and correlation matrix used by her and her colleagues in their study, but unfortunately these did not arrive. In the absence of this material and based on what was disclosed in the Fennema et al (1990) study, an attempt was thus made to reconstruct a parallel version of the questionnaire Fennema et al (1990) used. (See appendix IV for the Afrikaans version and appendix V for the English version).

The "reconstruction" of the questionnaire was a complex task, because Fennema et al (1990) did not elaborate fully on the research instruments in their article. However, through their discussion of the results it was possible to produce a *conceptually parallel* version of the questionnaire. The description of the Attribution Interview and the Sex-role Stereotype Questionnaire (as discussed in chapter 3) formed the basis for the construction of the interviews for the present research project.

Section A of the questionnaire gathered information about the teachers in terms of experience, age, gender and language. Questions were also asked about the type of school

in which the teachers worked as well as the number of girls and boys in the grade 9 class.

Section B of the questionnaire contained the attribution interview. The attribution categories that were used are represented in Table 3.1 and were the same Fennema et al (1990) used. The phrase on the left-hand side was for the success category, while the phrase on the right-hand was for the failure category. The category *success* indicates that the students understood mathematical concepts. The category *failure* will be used when the student found it difficult to comprehend mathematical concepts or failed to understand them. The category *failure* may have different meanings for the most, and least, successful mathematics students. For the most successful mathematics students it is possible that they might not understand certain mathematical concepts and, for most of the time, this will refer to the reason why they had difficulty in understanding mathematical concepts. The least successful mathematics students might struggle with many mathematical concepts and will fail to master them.

The interviewer asked the questions according to the format laid down in the questionnaire. As in the Fennema study, teachers were first asked to name their most successful mathematics student. The teachers were shown the seven attribution categories for success and failure. The failure categories consisted of the same attributions but were to be read in the negative, for example, lack of ability and lack of effort.

Teachers were asked to name, for their most successful student, the *major* reason for success as well as the *major* reason for failure in the learning of mathematical

concepts. The selection of most and least successful mathematics students by each teacher, and the choice of one of the attributions that was considered to be the major reason for success and failure, was *repeated* until every teacher had selected their *two* most successful boy students, their *two* most successful girl students, their *two* least successful boys students and their *two* least successful girl students. As already noted, Fennema et al (1990) *do not* describe how this process of repeated selection was actually performed in their study.

Section C of the questionnaire was the sex-role stereotype questionnaire. In this part of the questionnaire, the teacher was asked to respond, via a Likert response format, to 20 statements about the characteristics of their best boy and best girl mathematics student. They responded in terms of their beliefs about the most successful boy and girl student in their class by selecting a response category on the Likert scale that they felt was most true of the character of that particular student (see Table 3.2).

4.3 Pilot Study

A pilot study was conducted with a male and female teacher in an Afrikaans High School in Cape Town. The interviews were conducted in the following manner:

(1) Firstly, they were asked to complete section A of the questionnaire that asked about gender, age, years of teaching, type of school, language of the teacher, language of instruction, and the number of boys and girls in their grade 9 classes

(2) Secondly, they were asked to name their most successful mathematics student. No mention was made

of gender. Then they had to name their second most successful mathematics student. Again, no reference was made to the gender of the student. Only after the second question, as in the Fennema study, was reference made to gender in order to find their *two* most successful male students and their *two* most successful female students. This process was repeated to find the names of their *two* least successful male, and *two* least successful female, students. In each instance the teachers were asked to write the names of the students in the appropriate space. They were then asked to select the *major reason* why they thought the students they selected succeeded in learning mathematical concepts as well as the major reason why they thought the students had difficulties, or failed, in learning mathematical concepts.

(3) In the third part of the pilot study the teachers were asked to indicate, via a Likert response format on a scale of 1 to 5, their response to twenty statements about the characteristics of their most successful boy, and their most successful girl, students.

The interviews for the pilot study went smoothly and the teachers understood the questions easily. For the attribution interview, it was only necessary to explain the selection of the *major* reason for success and failure *once;* from there onwards the teachers found it easy to complete the section on all eight of the students they had named. The completing of the Sex-role Stereotype interview also went smoothly after an explanation of the Likert scoring method. It was also stressed by the interviewer that it was the *teachers' beliefs* about the

characteristics of the best boy and best girl student, and not the students' beliefs that were being solicited.

4.4 Change in the research design

Problems occurred, in terms of the sampling, when the initial research design was operationalized. The initial intention to interview an equal number of Afrikaans speaking male and female grade 9 teachers proved problematic because of rapidly changing circumstances in the education system as a whole.

The rationalisation of teachers that occurred at the end of 1996 saw many mathematics teachers leaving the profession. All the schools that had been contacted for use in the present study lost at least one teacher and in many cases, two or three mathematics teachers. Many substitute teachers were used in the first 6 months of 1997. This substitution contributed to the fact that relatively few male mathematics teachers were found in the schools that were approached. The research design of the present study was therefore altered to accommodate only Afrikaans-speaking female teachers in co-educational schools. In this respect an exclusively female sample was used as in the Fennema (1990) study.

For the present study, 40 Afrikaans speaking teachers were selected from high schools in the northern suburbs of Cape Town and municipalities in the Western Cape (all were previously "Model C" schools). The schools in the northern suburbs that were used were in Bellville, Parow, Brackenfell, Durbanville, Kraaifontein, Kuilsrivier, Goodwood and Stellenberg. The teachers were all teaching standard 7 (grade 9) pupils in co-educational schools.

The schools varied in size, but they were mostly schools with student numbers of more than 500. The smallest school had 500 students with a staff of 24 teachers. In this particular school, the mathematics teachers were one female and two males. This was unusual, because most of the mathematics teachers in the other schools were female. The largest number of students in a school were found in a school with 1300 students, 54 staff members and 6 mathematics teachers. In this particular school, there were 5 female teachers and only one male teacher. A very positive response was received from all the schools that were approached to be part of the study.

4.5 Operationalisation

Most schools that were used in the present study, had four grade 9 mathematics teachers. This meant that at least ten schools had to be used in order to obtain 40 subjects. Teachers have a very high workload and it was difficult to find times that suited them as well as the researcher. Most of the schools that were used as part of the research lie within a radius of 40 kilometres from Cape Town. The two furthest schools were about 70 kilometres away. The distances that had to be travelled meant that data collection took a considerable amount of time.

In order to conduct the interviews, the interviewer first had to contact the schools, obtain the name of the head of the mathematics department, and then request permission to interview the mathematics teachers. Most of the schools approached had schooldays that lasted until approximately 14:30. The interviewer was also a mathematics teacher at one of the schools, and this meant that it was only possible to do the interviewing during

the afternoons or over weekends. The teachers of the school that was the furthest from Cape Town were interviewed over a weekend. Although the interview itself did not take long, teachers of the same school were not always available on the same day. This meant that the interviewer had, in some cases, to visit the same school two or three times.

The format of the interviews followed that of the pilot interviews discussed earlier in this Chapter. The interviews all went smoothly once a time and date was set for it to take place. The teachers were all very co-operative and generally understood what was asked of them. Gathering the responses from the teachers, regarding their best boy and best girl mathematics student, on the adjective checklist also went smoothly.

4.6 Statistical analysis

Although, as already indicated, the original research question and the research design had to be changed, the questionnaire remained the same. The questionnaire was administered to obtain two sets of gender-based scores for comparison, and these constitute the sample data for the present study. The statistical analysis of the data for the present study will be expressed in the following ways:

(1) averages
(2) frequency tables
(3) percentages
(4) t-tests statistics and associated p-values
(5) exploratory factor solutions

The data gathered in terms of Section A of the questionnaire is summarized in terms of *averages.* Data concerning the selection of most and least successful mathematics students, and the attributions for their success and failure (Section B), are expressed as *frequency counts.* Teachers' attributions for success and failure in terms of the seven categories presented, are expressed in terms of *percentages.*

Section C of the questionnaire dealt with the teachers' responses regarding the characteristics of their best boy and best girl mathematics students. As in the Fennema et al (1990) study, student's t-tests for unpaired values were used in order to explore differences in the means between the gender groups. Finally, exploratory *factor analyses* were used to explore evidence of structure in the responses of the teachers. This is a form of analysis that Fennema et al (1990) did not perform.

The results of all the different stages of analysis are presented in the next chapter along with the discussion of the findings.

CHAPTER 5

ANALYSIS AND DISCUSSION OF THE DATA

The interviews for the present research project were conducted over a period of eight weeks and the response of each teacher recorded. The raw data is given in full in appendixes I, II and III. The Afrikaans version of the questionnaire that was used, as well as a translated English version can be found in appendixes IV and V. The responses from the 40 teachers interviewed are complete and there are no missing data.

5.1 Interview data

Appendix I contains the raw data for the teachers that were interviewed in terms of their years of teaching experience, age, home language, the type of school, the language of instruction, number of boys and girls in their grade 9 classes as well as their choices concerning their most and least successful mathematics students.

The 40 teachers that were interviewed were white female Afrikaans-speaking teachers and they all went to university to obtain a degree as well as a teaching diploma. The average number of years of teaching was 10 years and the average age of the teachers was 37 years. The youngest teacher was 23 years old and she was in her first year of teaching. The oldest teacher was 54 years and she had 26 years experience. Normally a teacher will graduate at the average age of 23 and, if she teaches until the age of 40, she will accumulated some 17 years experience. From Appendix I it is clear that this is not

the case for all of the teachers in this study. One teacher (age 39) has only 7 years experience.

All the grade 9 classes taught by these teachers comprised boys and girls, with 26 students in the smallest class and 44 students in the largest class (some teachers had more than one class and gave the total number of students they taught in grade 9). The interviews were all conducted after the first term of the year, that is, in April and May of 1997. This means that all the students had written at least two tests, and had also been assessed for homework. It is common practice in these schools for continuous assessment of classwork to take place. Teachers thus had knowledge of their students' performance in mathematics.

The next part of the analysis is concerned with the selection of the most and least successful mathematics students and it will show if there is any significant difference in the allocation of most and least successful students by gender.

5.2 Most and least successful students

During the attribution interview the teachers were first asked to name their most successful mathematics student. They were asked to do this without any reference to the gender of the student. There was little difference in terms of gender in the selection of their best mathematics student. Referring to table 5.1, the frequency with which a boy/girl was selected as the most successful mathematics student, expressed as a percentage, was 47,5%/52.5%. Teachers were then asked to name their second most successful mathematics student,

again without specific reference to gender. The frequency with which teachers selected a boy/girl as their second most successful mathematics student, expressed as a percentage, was 30%/70%.

TABLE 5.1: Selection of the most and least successful mathematics students

Percentage	Most successful student	2nd most successful student	Least successful student	2nd Least successful student
Boy	47,5%	30,0%	55,0%	62,5%
Girl	52,5%	70,0%	45,0%	37,5%
Total	100,0%	100,0%	100,0%	100,0%

The teachers were then asked, again as a free choice, to name the two least successful mathematics students. From Table 5.1 the results show that a boy was selected as the least successful student 55%, and second least successful student 62,5%, of the time. A girl was selected as least successful student 45%, and second least successful student 37,5%, of the time. Although there is not a big difference in the selection of the least successful mathematics student, there is a considerable difference between the selection of the second least successful student. This means that this group of female teachers consistently chose girls as their most and second most successful students and boys as their least and second least successful students.

It should be noted here that it is possible, as indeed happened, that some teachers selected a boy or a girl to be their most successful *as well as* their least successful mathematics student. The cells of the resultant contingency table are thus not mutually exclusive with respect to gender.

A further frequency analysis was therefore performed on the teachers' selections. Table 5.2 shows a combination of the paired selections the teachers made in their free choice for their most successful and second most successful mathematics student. Table 5.2 is set up to show the data for the most successful boy and girl reading horizontally, while the data for the second most successful boy and girl is read vertically. In order to focus on any particular cell showing frequency and percentage values, the co-ordinates will be shown as (horizontal; vertical).

TABLE 5.2: Selection of most and second most successful students

		2nd Most successful student		
	Frequency Percentage	Boy[2]	Girl[2]	Total
Most successful student	Boy[1]	3 7,5%	16 40,0%	19 47,5%
	Girl[1]	9 22,5%	12 30,0%	21 52,5%
	Total	12 30,0%	28 70,0%	40 100,0%

Only 3 teachers (7,5%) selected a boy as the most successful *as well as* the second most successful mathematics student (boy[1]; boy[2]). On the other hand, 12 teachers (30%) selected a girl as most successful *as well as* second most successful mathematics student (girl[1]; girl[2]). When the teachers' choice for her most successful mathematics student was a boy, 40% selected a girl to be the second most successful student (boy[1]; girl[2]). When a girl was selected as the most successful mathematics student, 22,5% of the teachers selected a boy as second most successful mathematics student (girl[1]; boy[2]). The

total values for each row and column restates the values of columns 1 and 2 of Table 5.1 for the teachers' selection of the most, second most, least and second least successful mathematics students.

Although a girl was selected as the second most successful mathematics student more times than a boy was selected, this selection does not indicate that the teachers considered boys to be unsuccessful. ~~When a girl was selected as the most successful student, 40% of the teachers selected a boy to be the second most successful student.~~

The same analytical procedure was followed for the selection of the least, and second least, successful mathematics students. Again, these selections were made on the basis of free choice without any prompted reference to gender by the interviewer. The results are summarized in Table 5.3, which is read in exactly the same way as table 5.2.

TABLE 5.3: Selection of least and second least successful mathematics students

		2nd Least successful student		
	Frequency Percent	Boy[2]	Girl[2]	Total
Least successful student	Boy[1]	19 47,5%	3 7,5%	22 55,0%
	Girl[1]	6 15,0%	12 30,0%	18 45,0%
	Total	25 62,5%	15 37,5%	40 100,0%

From Table 5.3 it can be seen that a boy was selected as the least *and* second least successful mathematics student 47,5% (boy^1;boy^2) of the time, while the teachers selected a girl as least successful *and* second least successful students 30% of the time ($girl^1$;$girl^2$). When a boy was selected as the least successful mathematics student, only 7,5% of the teachers selected a girl as the second least successful student (boy^1;$girl^2$). When a girl was selected as least successful student, a boy was selected as second least successful student 15% of the time ($girl^1$;boy^2).

The above data analysis suggests that very little difference was found in teachers' selections of their most and least successful mathematics students on the basis of gender. As Table 5.1 indicates the respective boy/girl selections are 47,5%/52,5% and 55%/45% respectively. In the following section of the analysis, teachers' attributions for success and failure will be analysed to consider the extent of variation in their attributions in terms of gender.

5.3 Attributions

Up until now the concern has been with the comparison of teachers' free choice selections of most and least successful students. The present study also has an interest in the attributions that teachers made of students on the basis of gender. In other words, the present study is interested in the question: do teachers attribute causation for success and failure differently for boys and girls? It is important to emphasise that, as in the study done by Fennema et al (1990), "failure" does not necessarily mean consistent poor performance, but

also refers to the difficulty students have in learning new mathematical concepts. For the purpose of the discussion, the present study will refer to "failure" in this sense.

In the first part of the interview, which I described above, teachers were asked to name four students, the most successful and second most successful, as well as the least successful and second least successful mathematics students. No mention of gender was made when they were asked to name these four students.

To complete the attribution table (see Appendixes II & III), the following procedure was used. If, in the free choice selection of successful and unsuccessful students, teachers named a boy as the most, and second most, successful mathematics student, they were then asked to name their most and second most successful girl mathematics student. If their first two responses were both girls, they were asked to name their most successful and second most successful boy mathematics student. If their first two selections consisted of a boy and a girl, they were asked to name their second most successful boy and their second most successful girl.

The same procedure was followed for the selection of the least successful students. If the teacher named two boys as her least successful and second least successful mathematics student, she was then asked to name her least and second least successful girl student. If she selected two girls with her first two free choices, she was then asked to name her least and second least successful boy students. If the teacher selected a boy and a girl with the two free choices for least successful and second

least successful mathematics student, it meant that they were the least successful students in terms of gender. She was then asked to name her second least successful boy and her second least successful girl mathematics student.

In this way they were guided by the interviewer to name two boys and two girls in each of the successful/ unsuccessful categories, in total eight students for each teacher used.

After each teacher selected her eight students in the most and least successful categories, she was then shown a list of seven attributions, the same attribution categories Fennema et al (1990) used in their study. For each student they were asked to select the *major* reason why that particular student succeeded or had difficulty with the learning of mathematics. In other words, the teachers were asked to assign seven attributions for *success* and *failure* for each of the students they selected (see table 3.1). The attributions for *failure* consisted of statements with the addition of "lack thereof" for each of the given categories. Although it is possible that more than one of the categories had an influence on the success or failure of a student to learn new mathematical ideas, the teachers were asked to name the most important personally considered cause for success and failure. The teachers' responses to these attributions are summarized in tables 5.4 and 5.5 as percentages.

Referring to Table 5.4, the success of the most successful girls and boys was respectively attributed to: ability, 28,75% and 45%; effort, 53,75% and 32,5%;

intrinsic motivation, 17,5% and 11,25%; task, 0% and 1,25%; help (from the teacher and other), 0% and 7,5%. The most successful boys' successes were attributed mostly to ability (45%) and effort (32,5%), while the most successful girls' successes were attributed predominantly to effort (53,75%).

TABLE 5.4: ATTRIBUTIONS: MOST SUCCESSFUL STUDENTS

Most Successful Mathematics Students					
		Success		Failure	
#	Categories	Girls	Boys	Girls	Boys
1	Ability	28,75	45,0	26,25	20,0
2	Effort	53,75	32,5	7,5	35,0
3	Intrinsic Motivation	17,5	11,25	1,25	3,75
4	Task	0	1,25	41,25	32,5
5	Teacher Help	0	7,5	0	2,5
6	Others Help	0	0	0	0
7	Other Reasons	0	2,5	23,75	6,25

The responses for each category are expressed as a percentage
Teachers' selections for each category totals 80

The teachers' attributions for the most successful girl/boy failure were respectively: lack of ability, 26,5% and 20%; lack of effort, 7,5% and 35%; lack of intrinsic motivation, 1,25% and 3,75%; task, 41,25% and 32,5%; lack of help (the teacher and other), 0% and 2,5% and other reasons, 23,75% and 6,25%. Obvious differences between teachers' attributions of the successful girls' and boys' failure were in terms of lack of effort and other reasons, where the girls obtain an unusually high score for *other reasons* (23,75%).

There is a notable *difference* in the attributions that teachers selected for the causes of success and failure

for the most successful boys and girls respectively. The attributional causation of success for the most successful girl students, is clearly effort (53,75%), and that for the boys ability (45%) and, to a lesser extent, effort (32,5%). The attributional causation of failure for the most successful girl students, is the task difficulty (41,25%) and for the boys effort (35%) and also task difficulty (32.5%).

In the attributions teachers made about the least successful boys and girls, as shown in Table 5.5, only a few differences are apparent. In the success category, the girls scored 23,75% for effort whereas the boys scored only 8,75%. There is little difference between task, girls 18,75% and boys 26,25%, but a much bigger difference between teachers' help: girls 43,75% and boys 28,75%.

TABLE 5.5 ATTRIBUTIONS: LEAST SUCCESSFUL STUDENTS

Least Successful Mathematics Students					
		Success		Failure	
#	Categories	Girls	Boys	Girls	Boys
1	Ability	7,5	15,0	41,25	42,5
2	Effort	23,75	8,75	31,25	31,25
3	Intrinsic Motivation	0	7,5	16,25	18,75
4	Task	18,75	26,25	8,75	2,5
5	Teacher Help	43,75	28,75	0	3,75
6	Others Help	3,75	5,0	0	0
7	Other Reasons	2,5	8,75	2,5	1,25

The responses for each category are expressed as a percentage

It is interesting to note that in the failure category of the least successful mathematics students very small differences are recorded. The main reasons given for failure of the least successful girls/boys are ability

(41,25%/42,5%), effort (both 31,25%) and to a lesser extent intrinsic motivation (16,25%/18,75%).

The attributions for success of the least successful mathematics students reveal little difference: boys (teacher's help and task) and girls (teachers help), while their failure is attributed mainly to ability and to a lesser extent effort, for the boys as well as for the girls.

Thus, in summarising the findings of the attribution interviews it appears that the attributions for success and failure reveal few differences on the basis of gender. The causation for success of the most successful students differs slightly between the boys (ability) and the girls (effort) but task difficulty is rated as the major reason for failure for both the boys and the girls. This pattern of causation *confirms* the findings of Fennema et al (1990) to a large degree. The only difference between the findings by Fennema et al (1990) and the present study is that they found both effort and task as the major reason for failure of the most successful boy students.

The causation of success of the least successful student also differs slightly between the girls (effort and help from teacher) and boys (help from teacher and task) but effort and ability are rated as the major reason for failure for both the boys and the girls. This also confirms the findings of Fennema et al (1990) to a large extent regarding their least successful mathematics students. The comparison between the results of the present study and the Fennema study will be discussed further in Chapter 6.

Up to this point the present study has addressed two of the three main questions which it set out to address. The last section of the analysis is concerned with teachers' beliefs regarding the characteristics of their best boy *and* best girl mathematics student. The question that will be addressed in the following section is: Do teachers hold different beliefs about the characteristics of their best boy and best girl mathematics student?

5.4 Adjective check list

A further analysis of the data is based on teachers' responses on the adjective checklist regarding the *characteristics* of their most successful boy, and most successful girl, mathematics student. These responses were subjected to t-test analysis in order to find if any significant differences occurred in teachers' attributions regarding the characteristics of their best boy and best girl mathematics student. The comparison of these results to those of the research done by Fennema et al (1990) will be discussed in chapter 6. Factor-analysis was used to explore gender-based differences in the correlation structure of the responses.

5.4.1 T-test analyses

Teachers were asked to respond to 20 statements in the questionnaire with respect to their most successful boy and most successful girl mathematics student. Table 5.6 contains the values of the means and standard deviations for the responses on each of the 20 statements by the 40 female teachers.

TABLE 5.6 ADJECTIVE CHECKLIST: DESCRIPTIVE STATISTICS AND T-TEST STATISTICS BY ITEM

#	Item	Best Boy Student		Best Girl Student		
		Mean	SD	Mean	SD	$t_{(40)}$
1	Not aggressive/Very aggressive	1,88	1,20	2,18	1,36	-1,050
2	Not independent/Very independent	4,10	1,03	4,05	0,99	0,2215
3	Very subjective/Very objective	3,40	0,90	3,30	0,99	0,4721
4	Very easily influenced/Not easily influenced	3,65	0,98	3,88	0,79	-1,1334
5	Very submissive/Very dominant	2,90	1,105	2,40	1,128	2,0031*
6	Very passive/Very active	3,35	0,92	3,23	1,05	0,5660
7	Not at all competitive/Very competitive	3,975	0,80	3,85	0,92	0,6479
8	Very illogical/Very logical	4,40	0,71	4,28	0,75	0,7657
9	Very indirect/Very direct	3,875	0,91	3,775	1,03	0,4612
10	Not at all adventurous/Very adventurous	3,33	0,80	3,30	0,85	0,1354
11	Very quiet/Very loud	2,175	1,08	2,125	1,20	0,1954
12	Has difficulty making decisions/Makes decisions easily	3,95	0,88	3,95	0,71	0,0000
13	Almost never acts as leader/Almost always acts as leader	3,325	0,83	3,25	0,98	0,3695
14	Very strong need for security/Very little need for security	3,325	0,997	3,125	0,911	0,9365
15	Not at all self-confident/Very self-confident	3,90	0,78	3,90	0,87	0,0000
16	Very uncomfortable about being aggressive/Not uncomfortable about being aggressive	2,75	1,35	2,43	1,28	1,1037
17	Seldom volunteers answers to mathematics problems/Often volunteers answers to mathematics problems	3,68	1,29	3,80	1,22	-0,4448
18	Does not enjoy mathematics very much/Enjoys mathematics very much	4,60	0,59	4,48	0,60	0,9402
19	Very dependent in mathematics/Very independent in mathematics	4,53	0,85	4,05	1,06	2,2129**
20	Does not persist on hard mathematics tasks/Very persistent on hard mathematics tasks	4,38	0,93	4,55	0,597	-1,0053

Scores lower than 2,5 indicates a higher agreement with the left-hand phrase
* $p < 0.05$ ** $p < 0.025$

The responses were scored using a "Likert type" response format, as in the Fennema et al (1990) study, with five possible options for each statement. The value of the response of each teacher regarding each statement was summed to give the total value for each statement. In order to find the mean, the total value is divided by the number of responses. Table 5.6 also lists the descriptive statistics and t-test statistics of teachers' responses on each of the phrases on the Adjective Checklist.

Teachers gave significantly different ratings for girls and for boys on only two of the items. These items are very submissive/very dominant and very dependent in mathematics/very independent in mathematics. In each case, teachers indicated that the phrase on the left was more descriptive of girls, and therefore, the phrase on the right more descriptive of boys.

Ratings on the Adjective Checklist were carefully considered to find the highest ratings for boys and girls. The highest ratings for girls were:

- very persistent in maths,
- enjoy maths,
- very logical,
- very independent in maths and
- very independent.

The highest ratings for the boys were very similar:

- enjoys maths,
- very independent in maths,
- very logical,
- persistent in maths and
- very independent.

In the following four categories: enjoy mathematics, very logical, very independent in mathematics and very independent, the boys scored a higher rating than did the girls. The girls scored higher in the category: very persistent in mathematics. The only significant difference between the scores of the boys and girls, as allocated by the teachers, is independence in mathematics ($p < 0.025$). The four lowest ratings for the boys (from the lowest) were:

- very aggressive,
- very loud,
- not uncomfortable about being aggressive and
- very dominant.

The four lowest ratings for the girls (from the lowest) were:

- very loud,
- very aggressive,
- very dominant and
- not uncomfortable about being aggressive.

The four lowest ratings for the boys as well as the girls were thus on the same four categories, although the order of rating differs. The only significant difference between the score of the boys and girls, as allocated by the teachers, was found in the response for the category: very dominant ($p < 0.05$). As indicated in chapter 3, a p-value of less than 0.05 means that the null hypothesis of no differences between mean scores is rejected at the five-percent level.

In order to extend the research conducted by Fennema et al (1990) the data gathered from the responses of the teachers on the 20 characteristics of the Adjective

Checklist was subjected to factor-analysis to explore the latent empirical structure of the responses to the instrument that they used.

5.4.2 Exploratory factor-analysis

The study by Fennema et al (1990) does not explore the extent to which responses to the Adjective Checklist are correlated, or the degree to which any shown correlation may allow a reduction in the multivariate complexity of the responses. That is, Fennema et al (1990) did not explore the latent (empirical) structure of their instrument. In their study, in the absence of any such exploration, it can be argued that they may thus have implicitly assumed that the 20 characteristics being measured were linearly *independent* of one another.

In the present study exploratory factor-analysis was successfully used to reduce the multivariate complexity of the data to a smaller set of *common factors* that represent dimensions of variation within which all of the students contributing to the analysis vary relative to one another. The internal consistency (coefficient alpha) of any exhibited factors was further explored using item-correlation analysis.

Factor-analysis sets out to represent a set of variables in terms of a smaller number of unobserved composite variables. For the present study the responses of the teachers to the 20 items of the Adjective Checklist constitute *observed* variables. The present study has two sets of such data: one set for boys and one for girls. Exploratory factor-analysis was independently performed

on the response data by gender. The results of the exploration can be seen in Tables 5.7 and 5.8. (Items with negative loadings are interpreted as 'in the absence of'.)

Table 5.7 Rotated Factor Pattern: Girls

Item	Description	F1	F2	F3
5	Very submissive/Very dominant	87*	21	.
11	Very quiet/Very loud	86*	27	.
16	Very uncomfortable about being aggressive/Not uncomfortable about being aggressive	85*	21	.
1	Not aggressive/Very aggressive	76*	24	.
6	Very passive/Very active	71*	31	28
10	Not at all adventurous/Very adventurous	66*	32	.
9	Very indirect/Very direct	-63	.	42
4	Very easily influenced/Not easily influenced	-66	.	45
2	Not independent/Very independent	-75	29	29
3	Very subjective/Very objective	-85	.	20
8	Very illogical/Very logical	.	86*	.
15	Not at all self-confident/Very self-confident	.	83*	-23
12	Has difficulty making decisions/Makes decisions easily	.	77*	22
17	Seldom volunteers answers to mathematics problems/Often volunteers answers to mathematics problems	23	60*	.
13	Almost never acts as leader/Almost always acts as leader	28	60*	22
19	Very dependent in mathematics/Very independent in mathematics	-35	.	81*
18	Does not enjoy mathematics very much/Enjoys mathematics very much	.	46	62*
14	Very strong need for security/Very little need for security	-32	.	62*
7	Not at all competitive/Very competitive	38	44	61*
20	Does not persist on hard mathematics tasks/Very persistent on hard mathematics tasks	-35	43	45

F1 = Factor 1; F2 = Factor 2; F3 = Factor 3
Factor-loadings are multiplied by 100 and rounded
* Indicates factor-loadings higher than 50
. Factor loadings with an absolute value ≤ 20 are printed as a period

The factor solutions presented in Tables 5.7 and 5.8 are *orthogonal* (varimax) solutions; that is, the factors are linearly independent of one another. Furthermore, within each of the exploratory three-factor solutions there are, in terms of the discrete factor compositions, *groups of*

items that have been empirically identified as substantially defining a particular dimension of variation. A conceptual comparison of these factor compositions is thus of interest *across* the gender groups, as is the internal consistency of the factors themselves (or elements thereof).

Table 5.8 Rotated Factor Pattern: Boys

Item	Description	F1	F2	F3
19	Very dependent in mathematics/Very independent in mathematics	88*	.	.
8	Very illogical/Very logical	87*	.	.
20	Does not persist on hard mathematics tasks/Very persistent on hard mathematics tasks	86*	.	.
18	Does not enjoy mathematics very much/Enjoys mathematics very much	66*	.	.
2	Not independent/Very independent	54*	.	.
12	Has difficulty making decisions/Makes decisions easily	52*	37	.
7	Not at all competitive/Very competitive	42	40	.
16	Very uncomfortable about being aggressive/Not uncomfortable about being aggressive	.	79*	27
9	Very indirect/Very direct	.	74*	-27
15	Not at all self-confident/Very self-confident	30	69*	26
17	Seldom volunteers answers to mathematics problems/Often volunteers answers to mathematics problems	27	62*	23
3	Very subjective/Very objective	56*	60*	21
4	Very easily influenced/Not easily influenced	.	53*	.
10	Not at all adventurous/Very adventurous	20	43	77*
11	Very quiet/Very loud	-23	.	76*
5	Very submissive/Very dominant	.	.	70*
6	Very passive/Very active	41	.	62*
1	Not aggressive/Very aggressive	-23	55*	57*
14	Very strong need for security/Very little need for security	34	.	49*
13	Almost never acts as leader/Almost always acts as leader	.	.	43*

F1 = Factor 1; F2 = Factor 2; F3 = Factor 3
Factor-loadings are multiplied by 100 and rounded
* Indicates factor-loadings higher than 50
. Factor-loadings with an absolute value ≤ 20 are printed as a period

5.4.3 Comparison of the factor-solutions

The following section discusses a comparison of the orthogonal factor solutions. By inspection it seems clear that the two solutions are not identical, but yet there are sufficient similarities across some of the factors to allow for a speculative interpretation. If we look at the items exhibiting high loadings (only items with a loading higher than 50 are arbitrarily being selected for comparative purposes), then we see that these factors (for the girls and boys) contain similarities but also differences. Some items will appear in one and not the other and they indicate a *possible source* of gender difference.

- It appears that factor 1 for the girls is capturing a similar dimension of variation to factor 3 for the boys. What is common across these 2 factors is item-based variation dealing with aggression, dominance, activeness, adventurousness and loudness. There appears to be only one difference: uncomfortable being aggressive/ not uncomfortable being aggressive is part of factor 1 for the girls and has a high loading. No other items are included in factor 3 for the boys.
- Furthermore, it appears factor 2 for the girls and factor 2 for the boys are also capturing a common dimension of variation. The similarities lie in item-based variation dealing with self-confidence and volunteering answers to mathematical problems. Differences appear between the items of these factors as well. Different items in factor 2 for the girls are concerned with logic, leadership and decision-making whereas factor 2 for the boys

contain items regarding objectiveness, directness, not easily influenced and not uncomfortable being aggressive.

- The third comparison is between factor 3 for the girls and factor 1 for the boys. The similarity arises by virtue of item-based variation such as enjoyment as well as independence in mathematics. Differences appear in terms of competitiveness and little need for security for the girls, and adventurousness for the boys.

It is also interesting to note that, in the grouping of the items according to the factor-loadings, item 3 (very submissive/very objective) has a loading higher than 50 in both factor 1 and 2. The same occurrence is found with item 1 (not independent/very independent) that has a loading higher than 50 in both factor 2 and 3 for the boys.

What emerges from this exploratory and speculative interpretation, is that a gender difference may exist, the basis of which is represented by the meanings of those selected items across which the gender factor patterns differ. On the strength of this exploration, further work might well be able to substantiate this speculative conclusion. A further question is whether the factors represent dimensions of variation that are *reliable* in the psychometric sense of internal consistency.

5.4.4 Item-correlation analysis

As a further exploration, the items exhibiting the highest loadings within each factor were subjected to

item-correlation analyses. The object of these analyses was to identify those groupings of items exhibiting the highest degree of internal consistency (coefficient alpha). The results of these item-correlation analyses are presented in Tables 5.9a and 5.9b.

TABLE 5.9a: LINEAR COMBINATIONS OF ITEMS THAT EXHIBIT INTERNAL CONSISTANCY: GIRLS

Group	#	Item
I α=0.93	1	Not aggressive/Very aggressive
	5	Very submissive/Very dominant
	6	Very passive/Very active
	10	Not at all adventurous/Very adventurous
	11	Very quiet/Very loud
	16	Very uncomfortable about being aggressive/Not uncomfortable about being aggressive
II α=0.84	8	Very illogical/Very logical
	12	Has difficulty making decisions/Makes decisions easily
	13	Almost never acts as leader/Almost always acts as leader
	15	Not at all self-confident/Very self-confident
	17	Seldom volunteers answers to mathematics problems/Often volunteers answers to mathematics problems
III α=0.72	7	Not at all competitive/Very competitive
	14	Very strong need for security/Very little need for security
	18	Does not enjoy mathematics very much/Enjoys mathematics very much
	19	Very dependent in mathematics/Very independent in mathematics

The items derived from factor 1 (Group I) for the girls, as shown in Table 5.9a, are concerned with their *personal attributes* (α = 0.93). The second grouping (Group II) for the girls refers to their *general characteristics*

(α = 0.84). The last grouping (Group III) for the girls refers more to the mathematics *classroom behaviour* (α = 0.72).

TABLE 5.9b: LINEAR COMBINATION OF ITEMS THAT EXHIBIT INTERNAL CONSISTENCY: BOYS

Group	#	Item
I α=0.87	2	Not independent/Very independent
	3	Very subjective/Very objective
	8	Very illogical/Very logical
	12	Has difficulty making decisions/Makes decisions easily
	18	Does not enjoy mathematics very much/Enjoys mathematics very much
	19	Very dependent in mathematics/Very independent in mathematics
	20	Does not persist on hard mathematics tasks/Very persistent on hard mathematics tasks
II α=0.79	1	Not aggressive/Very aggressive
	3	Very subjective/Very objective
	4	Very easily influenced/Not easily influenced
	9	Very indirect/Very direct
	15	Not at all self-confident/Very self-confident
	16	Very uncomfortable about being aggressive/Not uncomfortable about being aggressive
	17	Seldom volunteers answers to mathematics problems/Often volunteers answers to mathematics problems
III α=0.72	1	Not aggressive/Very aggressive
	5	Very submissive/Very dominant
	6	Very passive/Very active
	10	Not at all adventurous/Very adventurous
	11	Very quiet/Very loud

Table 5.9b shows the corresponding item groupings for the boys. The groupings differ from those for the girls in some ways as discussed earlier. The items in Group I

refer to boys' *independence* in general as well as in mathematics (α = 0.87). The second group refers to their *confidence* (α = 0.79) and the third group for the boys is also concerned with the *personal attributes* (α = 0.72) of the best boy. The alpha-value for each grouping reflects the degree to which the corresponding items represent a unidimensional construct.

From these item-correlation analyses it is clear that such empirically selected subgroups of the original 20 items *are not linearly independent;* that is, there is an underlying correlation structure in the responses that was not reported in the Fennema et al (1990) study. The results of the exploratory factor-analyses and item-correlation analyses lead one to question the value in the initial Fennema study of treating the 20 descriptors as independent variables. These results suggest that further work in looking at gender differences in teachers' attributions should be sensitive to these underlying composite sources of variation and the reliability with which they can apparently be measured.

In Chapter 6 the results of the present study will be compared to those of the Fennema study and conclusions drawn from it.

CHAPTER 6

COMPARISON AND CONCLUSION

The purpose of the present study was to explore teachers' beliefs regarding their male and female mathematics students, partially replicating aspects of a study by Fennema et al (1990). I am therefore interested to compare my results with the study I set out to partially replicate.

6.1 Comparison and discussion

The teachers used in the present study as well as the Fennema study were all female teachers. The present study deviates from the Fennema study in a number of respects. Fennema et al (1990) used all first-grade English-speaking students in the USA whereas the present study used grade 9 students from Afrikaans speaking schools in South Africa.

The first comparison between the two studies I will focus on is that concerned with the teachers' selection of most and least successful students. The present study produced different results in some respects to those generated by the Fennema study as is shown in Table 6.1.

As reflected in Table 6.1 there is a difference in the selections made by mathematics teachers regarding their most and least successful mathematics students. Fennema et al (1990) found that 79% of the teachers believed a boy to be their most successful mathematics student, whereas the present study found very little difference in the selection of the most successful student: a boy 47,5%

and a girl 52,5%. In the selection of the second most successful mathematics student the Fennema study found 58% of the teachers selected a boy as the second most successful student, while the present study found that only 30% of the teachers selected a boy as the second most successful student.

Table 6.1: Selection of most and least successful students

PS	Description	FS
30%	Teachers selecting **no boys** as their two most successful students	8%
7,5%	Teachers selecting **no girls** as their two most successful students	45%
47.5%	Teachers selecting a **boy** as their most successful student	79%
30%	Teachers selecting a **boy** as the second most successful student	58%
70%	Teachers selecting "at least" one boy as their least successful students	82%
52,5%	Teachers selecting "at least" one girl as their least successful students	61%

PS - Present Study
FS - Fennema Study

In selecting their most successful students 45% of the teachers in the Fennema study chose *no girls* and only 8% chose *no boys*. The present study found that only 7,5% of the teachers that participated in the study chose *no girls* and 30% chose *no boys*.

It is more difficult to make a comparison between the results of the Fennema study and the present study with regard to the least successful mathematics students. Very little information is provided by Fennema et al (1990) regarding teachers' selection of their least successful students. Their focus was far more on selection of most successful students. Both the studies found that a higher percentage of the teachers that participated selected

boys more often as one of their least successful students. In the Fennema study a boy was selected as one of the least successful students by 82% of the teachers with 70% of the teachers making a similar selection in the present study. On the other hand, 61% of the teachers in the Fennema study selected a girl as one of the least successful students with 52,5% of the teachers making the same selection in the present study.

The present study suggests that teachers regarded girls as their more successful mathematics students. Although there was little difference along gender lines in their selection of their most successful students, there is a considerable difference in their selection of their second most successful student. A girl was selected as the second most successful student by 70% of the teachers, whereas a boy was selected as the second most successful student by only 30% of the teachers. This suggests that teachers considered their female students to be more successful overall in mathematics. The same pattern can be detected in the case of the least successful mathematics students. Although there is little difference in the selection of their least successful mathematics students, 62,5% of the teachers selected a boy as the second least successful student compared to 37,5% of the teachers who selected a girl as the second least successful student. This is a further indication that the teachers that participated in the present study regarded girls as more successful overall than boys.

The second comparison between the present study and that of Fennema et al (1990) is concerned with the difference in attributional causes, if any, for success and failure of their most and least successful students. It is

interesting to note very similar findings between the two studies with regard to attributions the teachers made for the success and failure of the students they selected. Table 6.2 shows the teachers' responses on the attribution interview for the two studies.

Table 6.2: Attributions

Groups	Present Study	Fennema Study
MS Girls: Success	Effort (53,75%) Ability (28,75%)	Effort (37%) Ability (33%)
MS Girls: Failure	Task (41,25%) Ability (26,25%) Other Reasons (23,75%)	Task (40%) Effort (24%)
MS Boys: Success	Ability (45%) Effort (32,5%)	Ability (58%)
MS Boys: Failure	Effort (35%) Task (32,5%)	Task (45%) Effort (25%)
LS Girls: Success	Teacher's Help (43,75%) Effort (23,75%)	Effort (32%) Teacher's Help (24%)
LS Girls: Failure	Ability (41,25%) Effort (31,25%)	Ability (29%) Effort (28%) Task (28%)
LS Boys: Success	Teacher's Help (28,75%) Task (26,25%)	Teacher's Help (35%) Effort (24%)
LS Boys: Failure	Ability (42,5%) Effort (31,25%)	Effort (33%) Ability (22%)

MS - Most successful
LS - Least successful

Referring to Table 6.2, the present study found that teachers regarded ~~*ability*~~ effort (53,75%) as the most important cause for success for the most successful girl students whereas the Fennema study found a more similar causation between *effort* (37%) and *ability* (33%). The main reason for failure of this particular group is shown by both studies to be the *difficulty of the task*.

On the other hand the present study concluded that the most successful boys' successes are largely attributed to *ability* (45%) and *effort* (32,5%) and the Fennema study regarded *ability* (58%) as the most important reason. The failure of boys is ascribed to both *effort* (35%) and *task*

(32,5%) in the present study and mainly to *task* (45%) by the Fennema study. Little difference is found in the attribution pattern by these groups of teachers for success and failure by their most successful students.

The present study shows that attributional cause for success of least successful girls is mainly *help from teacher* (43,75%). The Fennema study confirms this (24%) but considers *effort* (32%) as a stronger possible cause. Both studies conclude that failure of the least successful girls is mainly because of *ability* and to a lesser extent *effort*. The least successful boys' successes are mainly attributed to *teacher's help* by both studies but the present study found *task* (26,25%) to be a contributing cause. The Fennema study concluded that apart from *teacher's help* (35%), *effort* (24%) also plays a part in their successes. Both studies found *ability* and *effort* to be the main causes for failure by their least successful boys.

The last part of the interviews conducted in both studies was concerned with the teachers' beliefs regarding the characteristics of their best boy and best girl mathematics student. Table 6.3 gives a summary of the findings of both studies regarding teachers beliefs about the characteristics of their best boy and best girl mathematics student.

In both studies teachers attributed the same traits to their best boy and best girl mathematics students. Teachers that took part in the Fennema study gave higher ratings for their best boy than teachers in the present study did.

Table 6.3: Characteristics - Highest and Lowest Mean Scores

	Present Study	Fennema Study
Best Boy: Highest	1.Enjoys maths (4,6) 2.Very independent in maths (4,5) 3.Very logical (4,4) 4.Very persistent on hard maths tasks (4,4) 5.Very independent (4,1)	1.Enjoys maths (4,9) 2.Very independent in maths (4,7) 3.Volunteers answers (4,7) 4.Very logical (4,6) 5.Very persistent on hard maths tasks (4,1)
Best Boy: Lowest	1.Not aggressive (1,9) 2.Very quiet (2,2) 3.Very uncomfortable being aggressive(2,8) 4.Very submissive (2,9)	1.Not aggressive (2,7) 2.Strong need for security (2,9) 3.Very uncomfortable being aggressive (3,2) 4.Very quiet (3,2)
Best Girl: Highest	1.Very persistent on hard maths tasks (4,6) 2.Enjoys maths (4,5) 3.Very logical (4,3) 4.Very independent in maths (4,1) 5.Very independent (4,1)	1.Enjoys maths (4,5) 2.Very independent in mathematics (4,3) 3.Very independent (4,3) 4.Very logical (4,2) 5.Makes decision easily (4,1)
Best Girl: Lowest	1.Very quiet (2,1) 2.Not aggressive (2,2) 3.Very submissive (2,4) 4.Very uncomfortable being aggressive (2,4)	1.Not aggressive (2,6) 2.Very quiet (2,8) 3.Strong need for security (3,1) 4.Very uncomfortable being aggressive (3,2)

The values in brackets are the mean scores of the teachers' responses on a "Likert type" response format

In the study of Fennema et al (1990) teachers gave significantly different ratings for boys and girls on the following items: Not at all competitive/very competitive; Very illogical/very logical; not at all adventurous/ very adventurous; Seldom volunteers answers to mathematical problems/often volunteers answers to mathematical problems; Does not enjoy mathematics very much/enjoys mathematics very much; Very dependent in mathematics/very independent in mathematics. In each of the above-mentioned cases, teachers gave a higher rating for the boys than the girls.

The present study found only two descriptive phrases where teachers gave significantly different ratings for

the boys than the girls: Very submissive/very dominant and Very dependent in mathematics/very independent in mathematics. In both cases the mean scores of the boys was the higher score.

Although Fennema et al (1990) found significant differences on six items between the responses of the teachers regarding their best boy and best girl mathematics students, the present study reveals very little difference. The only item of correlation in both studies is *very dependent in mathematics/very independent in mathematics*. The means of the individual items of the present study indicates that teachers saw the same traits in their best boy and their best girl student. Teachers did not give their boy students significantly higher ratings, as was the case in the Fennema study.

The present study extended the work of Fennema et al (1990) by conducting an exploration of response structure. There is no mention by Fennema et al (1990) that they carried this out and thus assumed that the 20 characteristics on the attribution schedule were independent of one another. They treated the response data as if these were independent entities. This observation is made because there is no mention of this in the Fennema study, yet it appears reasonable to expect that there will be some interrelationship. Through exploring structure by using factor-analysis the present study found that there are 3 groups that show some form of association. The alpha-value for each group shows that there appears to be an underlying structure in the response data. The exploratory factor analysis also shows that there appears to be gender difference.

To summarize, in selecting most and least successful students, it is clear that differences exist between the two studies regarding teachers' beliefs about their most and least successful students.

- Teachers in the Fennema study regarded boys to be their more successful students whereas the present study concluded that teachers believed girls to be their more successful mathematics students.
- The two studies show that teachers attributed causes for success and failure similarly. They differ in the attributions for success between the most successful boys and most successful girls. Boys' successes were attributed mainly to ability and girls' successes to effort and ability.
- The present study concluded that teachers believed that there was very little difference between the characteristics of their best boy and best girl mathematics students whereas in the Fennema et al (1990) study, teachers perceived that the best boys showed stronger characteristics than did the best girls.

Fennema et al (1990) did not explore the existence of response structure and therefore it is impossible to comment on possible differences in the exploration of structure between the two studies. The present study extended the work of Fennema et al (1990) by exploring structure of the responses on the Adjective Checklist. This suggests further work, as indicated at the end of Chapter 5.

Unfortunately the present study was unable to use both male and female teachers' responses. Do male teachers attribute success and failure differently for boys and

girls? Do age and experience of teachers influence their belief systems?

6.2 Implications and limitations of the present study

In my own study I have attempted to replicate aspects of the Fennema study and have presented a comparison of the results. This comparison suggests that not all teachers regard boys as their most successful students of mathematics, and so a *general* statement that teachers regard boys as their best performers in mathematics cannot be sustained. There are, however, important contextual differences between the two studies which may explain the differences in findings. The Fennema study used teachers of grade 1 students with possibly little prior knowledge of their performance in mathematics. The present study used teachers of grade 9 students and were possibly more aware of their previous performance in mathematics. Grade 1 teachers are unlikely to be specialists in mathematics as would be the case with secondary school teachers. The Fennema study took place in the USA, amongst English-speaking teachers and students whose social class composition and ethnic background we know little about. The present study took place with white Afrikaans-speaking teachers in a relatively privileged section of the schooling sector. Unfortunately the implications of these contextual features cannot be systematically analysed, as they are not incorporated into the data gathering instruments that were used. It is with respect to these contextual features that the main limitations of the present study lie and a discussion of them goes to the heart of a significant debate on gender and mathematics which is

exemplified by the work of Fennema on the one hand, and Valerie Walkerdine on the other.

It is interesting that the attributions for success and failure by their most and least successful students was similar for teachers in both Fennema's study and my own. Although teachers in the present study believed their girl students to be more successful than their boy students, they believed that the reason for success is largely determined by *effort* on the part of the girls and *ability* on the part of the boys. According to the Wiener classification (1974) teachers attribute girls' performance to internal, unstable cause that is subject to possible change and boys' performance to internal, stable cause.

While the present study and that of Fennema et al (1990) can highlight these dimensions in teachers' attributions, neither the present study nor theirs can explain it. Both studies start from the assumption that "gender of student should be an important variable in teacher attributions" (Fennema et al, 1990, p.57) and then set out using quantitative data-gathering instruments and statistical analysis to establish the extent to which this is the case. As Ensor (1991, p.9) comments with respect to the work of Fennema and others "there is an absence of an explicitly articulated theoretical framework in terms of which research questions are formulated, techniques selected and analyses grounded".

In contrast with Fennema and others, Walkerdine takes a gender-divided social domain as her starting point. Unlike Fennema, her focus is not upon the "individual", teacher or student but rather upon the subject positions

and meanings which are embedded within the language and practices of mathematics discourse. Like other post-structuralist writers she stresses the social and historical origins of subjectivity and of knowledge and demonstrates the role of language in the maintenance, modification and construction of shared meaning. Walker-dine (1989) argues that in order to understand girls' achievement in mathematics, it is necessary to trace how their performance is produced and evaluated in the context of broader discourses on masculinity and femininity.

Some classroom behaviour is taken to indicate "real understanding" or propositional knowledge of mathematics, for example, rule breaking and divergence. "Rote learning", which is associated with procedural knowledge, is linked to passivity, obedience and rule following. So the breaking of discipline rules by boys is seen as being divergent, whereas hard work and good behaviour on the part of girls is regarded as evidence of passivity and rule following.

Ensor (1991) argues

> Failure in girls is more likely to be attributed to innate lack; whereas boys are more likely, in spite of low attainment levels, to be seen to have innate natural ability. Children are thus constructed as good and poor at mathematics, and Walkerdine and others point to the difficulty many girls have in moving into a "masculine" positioning with respect to academic performance and a "feminine" one in relation to other context. Girls are thus trapped in a double-bind - no matter how hard they work and achieve, they are seen as not demonstrating "real understanding". When they do challenge the authority of the teacher, this is read as unco-operative behaviour, rather than as breaking set (Ensor, 1991, p.25).

Johnston (1986) has also argued that the achievement of girls in mathematics is attributed to "tidiness" and "strict adherence to rules" (p.218).

I earlier raised a number of questions of possible interest in extending the present study; the influence of the gender of teacher on the attribution of success and failure in students, age, experience and ethnicity. In researching these issues further, it would be important to combine structured with less structured interviewing techniques and develop a mode of data analysis which allowed for the incorporation of more contextual features. I found, for example, when conducting the interviews with teachers that they willingly responded to the questions posed. Once the interviews were completed, however, they provided a range of potentially rich data about how they viewed success and failure, how they evaluated their students. Teachers attributed success and failure to norms not on the attribution scale. For example one commented "for boys in grade 9 it won't be cool to work hard"; "girls have more emotional problems, relationships with boyfriends, choosing friends and so on". During the attribution interviews 24% of the teachers regarded "other reasons" for failure of the most successful girl students. There is no opportunity to open this up in a structured interview. Being able to incorporate this data would, I believe, produce a deeper and more nuanced account of how teachers construct success and failure in mathematics, and how this produces and reproduces gender difference.

BIBLIOGRAPHY

Abelson, R. (1979). Differences between belief systems and knowledge systems. *Cognitive Science, 3,* 355 - 366.

Aitken, L. R. (1971). Intellectual variables and mathematics achievement: direction for research. *Journal of School Psychology,* 9, 201 - 212.

Amstrong, J. M. (1981). Achievement and Participation of women in mathematics: results of two national surveys. *Journal for Research in Mathematics Education, 12(5),* 356 - 372.

Amstrong J.M. & Price R.A. (1982). Correlates and Predictors of Woman's Mathematics Participation. *Journal for Research in Mathematics Education, 13(2),* 99-109.

Backman M.E. (1972). Patterns of Mental Abilities: Ethnic, Socioeconomic, and Sex Differences. *American Educational Research Journal, 9(1),* 1-12.

Bar-Tal, D. & Frieze, J.H. (1977). Achievement motivation for males and females as a determinant of attributions for success and failure. *Sex Roles, 3,* 301 - 313.

Bar-Tal, D. & Guttman, J.(1981). A comparison of teachers', pupils' and parents' attributions regarding pupils' academic achievements. *British Journal of Educational Psychology, 51,* 301 - 311.

Becker, J. R. (1981). Differential treatment of females and males in mathematics classes. *Journal for Research in Mathematics Education, 12(1),* 40 - 53.

Benbow, C. P. (1988). Sex differences in mathematical reasoning ability in intellectually talented pre-adolescents: Their nature, effects, and possible causes. *Behavioural and Brain Sciences, 11,* 169 - 232.

Benbow, P. & Stanley, J. C. (1980). Sex differences in mathematical ability: Fact or artifact? *Science, 210(12),* 1262 - 1264.

Benbow, P. & Stanley, J. C. (1981). Mathematical ability: Is sex a factor? *Science, 212,* 118 - 121.

Benbow, P. & Stanley, J. C. (1983a). An eight year evaluation of SMPY: What was learned? In C. Benbow & J. Stanley (Eds.) *Academic Precocity: Aspects of Its Development*, Baltimore, MD: Johns Hopkins Press.

Benbow, P. & Stanley, J. C. (1983b). Sex differences in mathematical reasoning ability: More facts. *Science, 222,* 1029 - 1031.

Broverman, I. K., Broverman, D., Clarkson, F. E., Rosenkrantz, P. S., & Vogel, S. (1970). Sex-role stereotypes and clinical judgements of mental health. *Journal of Consulting and Clinical Psychology, 34,* 1 - 7.

Burton, L. (Ed). (1986). *Girls into Mathematics Can Go.* London: Holt, Rinehart & Wilson.

Bussis, A. M., Chittenden, F., & Amarel, M. (1976). *Beyond Surface Curriculum.* Boulder, Colorado: Westview Press.

Campbell, P. B. (1995). Redefining the "girl problem in mathematics". In W. G. Secada, E. Fennema & L. B. Adajian (Eds.), *New Directions for Equity in Mathematics Education.* USA: Cambridge University Press.

Clark, C. M.. & Peterson, P. L. (1986). Teachers thought processes. In M. C. Wittrock, (Ed.), *Third Handbook of Research on Teaching.* New York: Macmillan.

Conners, R. D. (1987). *An Analysis of Teacher Thought Processes, Beliefs, and Principles during Instruction.* Unpublished doctoral dissertation, University of Alberta, Edmonton, Canada.

Deaux, K. (1976). Sex: A perspective on the attribution process. In J. Harvey, W. Ickes and R. Kidd (Eds.), *New Directions in Attributional Research 1.* Hillsdale, NJ: Lawrence Eribaum.

Diener, C. & Dweck, C. (1978). An Analysis of Learned Helplessness. *Journal of Personality and Social Psychology, 25,* 109 - 116.

Dowling P. (1990). Some Notes Towards a Theoretical Model for Reproduction, Action and Critique. In R. Noss et al (Ed.), *Political Dimensions of Mathematics Education: Action & Critique*. Department of Mathematics, Statistics & Computing Education, Institute of Education, University of London, London.

Dowling, P. (1991). Gender, Class and Subjectivity in Mathematics: a critique of Humpty Dumpty. *For the Learning of Mathematics, 11(1),* 2 - 8.

Dunne, M. & Johnston, J. (1994). Research in Gender and Mathematics Education: The production of Difference. In P. Ernest (Ed.), *Studies in Mathematics Education Series 3 Mathematics, Education and Philosophy: An International Perspective* London: Falmer Press.

Dweck, C., Davidson, W., Nelson, S. & Enna, B. (1978). Sex Differences in Learned Helplessness. *Journal of Personality and Social Psychology, 36,* 457 - 462.

Ensor, P. (1994). Boundaries at the Centre - Differentiating Pupils in Mathematics Classrooms. *Perspectives in Education, 15(1),* 101 - 114.

Ensor, P. (1991). *Upsetting the Balance: Black girls and mathematics*. Unpublished Masters dissertation, Institute of Education, University of London.

Ernest, P. (1988). *The impact of beliefs on the teaching of mathematics.* Paper prepared for ICME VI, Budapest, Hungary.

Ernest, P. (Ed.). (1989). *Mathematics Teaching the State of the Art*. Basingstoke: Flamer.

Fennema, E. & Sherman, J. (1977). Sex-related differences in mathematics achievement, spacial visualization and affective factors. *American Education Research Journal, 14(1),* 51 - 71.

Fennema, E. (1980). Teachers and Sex Bias in Mathematics. *Mathematics Teacher, 73,* 169 - 173.

Fennema, E., Wolleat, P. L., Pedro, J. D. & Becker, A. (1981). Increasing women's participation in mathematics: an intervention study. *Journal for Research in Mathematics Education, 12(1),* 3 - 14.

Fennema, E. & Carpenter, T. P. (1981). Sex-related differences in mathematics: results from national assessment. *Mathematics Teacher, 74(7),* 554 - 559.

Fennema, E. (Ed.). (1985). Explaining sex-related differences in mathematics: Theoretical models. *Educational Studies in Mathematics, 16,* 303 - 320.

Fennema, E. & Peterson, P. L. (1985). Autonomous learning behaviour: a possible explanation of sex-related differences in mathematics. *Educational Studies in Mathematics, 16,* 309 - 311.

Fennema, E. (1987). Sex related differences in education: Myths, realities, and interventions. In V. Koehler (Ed.), *Educator's Handbook: Research into practice.* Longman.

Fennema, E., Carpenter, T. P. & Peterson, P. L. (1991). Teachers' decision making and cognitively guided instruction: A new paradigm for curriculum development. In K. Clements & N. F. Ellerton (Eds.), *Facilitating change in mathematics education.* Geelong, Victoria, Australia: Deakin University Press.

Fennema, E. (1990). Teachers' beliefs and gender differences in mathematics. In E. Fennema & G. Leder (Eds.), *Mathematics and Gender: Teacher and Student influences.* New York: Teachers College Press.

Fennema, E., Peterson, L., Carpenter, T.P. & Lubinski, C. A. (1990). Teachers' Attributions and beliefs about Girls, Boys and Mathematics. *Educational Studies in Mathematics, 21,* 55 - 69.

Fennema, E. & Leder, G. (Eds.) (1990). *Mathematics and Gender: Influences on Teachers and Students,* New York: Teachers' College Press.

Friedman, L. (1989). Mathematics and the gender gap: a meta-analysis of recent studies on sex differences in mathematical tasks, *Review of Educational Research, 59(2),* 185 - 213.

Goldstein H. (1986). Gender Bias and Test Norms in Educational Selection. *Research Intelligence,* 2 - 4.

Guskey, T. R. (1982). Differences in teachers' perceptions of personal control of positive versus negative student learning outcomes. *Contemporary Educational Psychology, 7,* 70 - 80.

Hall, C. W. (1989). Gender Differences in Mathematical Performance. *Educational Studies in Mathematics, 19,* 395 - 401.

Hanna, G. (1989). Mathematics Achievement of Girls and Boys in Grade Eight: Results from Twenty Countries. *Educational Studies in Mathematics, 20,* 225 -232.

Hallinan, M. T. & Sorenson, A. B. (1987). Ability grouping and sex differences in mathematics achievement. *Sociology of Education, 60,* 63 - 72.

Janesicki, V. (1977). *An Ethnographic Study of a Teacher's Classroom Perspective.* Unpublished doctoral dissertation, Michigan State University, East Lansing.

Johnston, J. E. (1986). *An experiment in the prediction of achievement in Senior Certificate Higher Grade.* Unpublished M.Ed Thesis, University of Cape Town.

Kimball, M. M. (1989). A new perspective on woman's math achievement. *Psychological Bulletin, 105,* 198 - 214.

King, E. J. (1968). *Comparative Studies and Educational Decision.* USA: The Bobbs-Merrill Company Inc..

Koehler, M. S. (1990). Classrooms, teachers and gender differences in mathematics. In E. Fennema & G. C. Leder (Eds.), *Mathematics and Gender.* New York: Teachers' College Press.

Lave, J. (1988). *Cognition in Practice.* Cambridge: Cambridge University Press.

Leder, G. C. (1985). Sex-related differences in mathematics: an overview. *Educational Studies in Mathematics, 16(3),* 304 - 309.

Leder, G. C. (1987). Teacher-student interaction: A case study. *Educational Studies in Mathematics, 18,* 255 - 271.

Leder, G. C. (1990). Teacher/student interaction in the mathematics classroom: A different perspective. In E. Fennema & G. C. Leder (Eds.), *Mathematics and Gender*. New York: Teachers' College Press.

Lefcourt, H. M., Von Baeyer, C. L., Ware, E. E. & Cox, D. J. (1979). The multidimensional - multiattributional Causality Scale: the development of a goal specific locus of control scale. *Canadian Journal of Behaviour Science, 11,* 286 - 304.

Lorenz, J. H. (1982). On some psychological aspects of mathematics achievement assessment and classroom interaction. *Educational Studies in Mathematics, 13(1),* 1 - 20.

Macleod, C. (1995). Gender differences in mathematics: a discourse analysis. *South African Journal of Psychology, 25(3),* 191 - 203.

Meyer, M. R. & Koehler, M. S. (1990). Internal influences on gender differences in mathematics. In E. Fennema & G. C. Leder (Eds.), *Mathematics and Gender: Influences on Teachers and Students*. New York: Teachers' College Press.

Minuchin, P. P. (1971). Sex-role concepts and sex typing in childhood as a function of school and home environments. In G. C. Thompson (Ed.), *Social Development and personality*. New York: John Wiley & Sons.

Mitchell, M. & Jolley, J. (1996). *Research Design Explained*. New York: Harcourt Brace College Publishers.

Munby, H. (1983), April, *A Qualitative Study of Teaches' Beliefs and Principles,* Paper presented at the annual meeting of the American Educational Research Association, Montreal, Canada.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies, 19,* 317 - 328.

Northam, J. (1986). Girls and boys in primary maths books. In L. Burton (Ed.), *Girls into Maths Can Go*. London: Holt, Rinehart & Winston.

Peters, M. (1991). Sex, handedness, mathematical ability, and biological causation. *Canadian Journal of Psychology, 45,* 415 - 419.

Peterson, P. L. and Barger, S. A., (1985). Attribution theory and teacher expectancy. In J. B. Dusek, V. C. Hall & W. J. Meyer (Eds.), *Teacher Expectancies*. New Yersey: Lawrence Erlbaum Associates.

Rose, G. (1982). *Deciphering Sociological Research*. London: MacMillan.

Scheffler, I. (1965). *Conditions of knowledge: An introduction to epistemology and education*. Glenview, IL: Scott, Foresman, and Company.

Shaw, M. E. & Wright, J. M. (1967). *Scales for the Measurement of Attributions*. McGraw Hill.

Sherman, J. & Fennema, E. (1977). The study of mathematics by high school Girls and Boys: Related Variables. *American Educational Research Journal, 14(2),* 159 - 168.

Shuard, H. (1986). The relative attainment of girls and boys in mathematics in the primary years. In L. Burton (Ed.), *Girls into Maths can go*. London: Holt, Rinehart & Winston.

Stallings, J. A. (1979). *Comparison of men's and women's behaviours in high school math classes*. Menlo Park, CA: SR1 International.

Tartre, L. A. (1990). Spatial skills, gender and mathematics. In E. Fennema and G. C. Leder (Eds.), *Mathematics and gender: Influences on Teachers and Students*. New York: Teachers' College Press.

Tatre, L. A. & Fennema, E. (1995). Mathematics Achievement and Gender: A Longitudinal Study of Selected Cognitive and Affective Variables Grades 6 - 12. *Educational Studies in Mathematics, 28(3),* 199 - 217.

Thompson, A. G. (1982). *Teachers' Conceptions of Mathematics Teaching: Three Case Studies*. Unpublished doctoral dissertation, University of Georgia, Athens.

Thompson, A. (1992). Teachers' Beliefs and Conceptions: A Synthesis of the Research. In A. D. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning*. New York: MacMillan Publishing Company.

Walden, R. & Walkerdine, V. (1982). Girls and mathematics: the early years. *Bedford Way Papers*. Institute of Education, University of London.

Walden, R. & Walkerdine, V. (1985). Girls and mathematics: from primary to secondary school. *Bedford Way Papers*. Institute of Education, University of London.

Walkerdine, V. (1980). Post-structuralist theory and everyday social practices: the family and the school. In S. Wilkenson (Ed.), *Feminist social psychology: developing theory and practice*. Milton Keynes: Open University Press.

Walkerdine, V. (1989). *Counting Girls Out*. London: Virago Press.

Walkerdine, V. (1990). *The Mastery of Reason: Cognitive development and the production of rationality*. London: Routledge.

Webb, N. M. & Kenderski, C. M. (1985). Gender differences in small-group interaction and achievement in high- and low-achieving classes. In L. C. Wilkenson & C. B. Marrett (Eds.), *Gender influences in classroom interactions*. New York: Academic Press.

Weiner, B. (1974). *Achievement Motivation and Attribution Theory*. Morristown New York: General Learning Press.

Wiener, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational Psychology, 71*, 3 - 25.

Wolleat, P. L., Pedro, J. D., Becker, A. D. & Fennema, E. (1980). Sex-Differences in High School Students causal attributions of performance in mathematics. *Journal for Research in Mathematics Education, 11(5)*, 356 - 360.

APPENDIX I

RAW DATA OF TEACHERS' RESPONSES

#	Exp	Age	Lang	Sch	L/I	#B	#G	MSS	2MSS	LSS	2LSS
1	17	39	A	K	AE	20	14	B	G	G	B
2	14	37	A	K	AE	13	24	B	G	B	B
3	03	25	A	K	AO	20	51	G	B	B	B
4	23	45	A	K	AO	15	27	G	G	G	G
5	11	42	A	K	AO	18	25	G	B	G	G
6	03	26	A	K	AO	19	24	G	G	B	G
7	18	48	A	K	AO	14	28	B	G	B	B
8	11	36	A	K	AO	15	29	B	G	G	B
9	17	38	A	K	AO	17	25	B	B	B	B
10	11	35	A	K	AO	24	13	B	G	G	B
11	23	45	A	K	AO	20	17	G	G	G	G
12	10	50	A	K	AO	22	18	B	G	G	B
13	07	29	A	K	AO	19	23	B	G	G	G
14	06	28	A	K	AE	39	46	B	B	G	B
15	16	45	A	K	AE	44	56	G	G	B	B
16	07	29	A	K	AE	15	16	B	G	B	B
17	08	40	A	K	AE	17	19	B	G	B	B
18	00	38	A	K	AO	23	15	G	G	G	G
19	07	29	A	K	AO	17	23	B	G	G	G
20	14	43	A	K	AO	32	40	B	G	B	B
21	01	23	A	K	AO	15	20	G	G	B	B
22	07	49	A	K	AO	30	41	B	G	B	B
23	26	54	A	K	AO	15	21	G	G	B	B
24	10	33	A	K	AO	21	17	G	B	B	B
25	07	39	A	K	AO	15	18	B	B	G	G
26	10	35	A	K	AO	20	22	G	B	G	G
27	22	44	A	K	AO	39	42	B	G	B	B
28	16	38	A	K	AO	19	15	B	G	G	B
29	14	36	A	K	AO	12	22	B	G	B	B
30	02	24	A	K	AO	24	47	G	B	B	B
31	20	42	A	K	AO	16	26	G	G	G	G
32	04	27	A	K	AO	18	25	G	G	B	G
33	08	30	A	K	AO	20	22	B	G	G	G
34	06	35	A	K	AO	33	37	G	B	G	G
35	04	26	A	K	AO	20	17	G	B	B	B
36	20	42	A	K	AE	42	08	G	G	B	B

37	05	38	A	K	AE	22	42	G	G	G	G
38	15	38	A	K	AO	17	20	G	G	B	B
39	11	34	A	K	AO	19	21	G	B	B	B
40	17	43	A	K	AE	37	71	G	B	B	G

Keys:
#- Teacher number
Age- Teachers' age
Sch- Co-ed (K)
#B- Number of boys
MSS- Most successful student
LSS- Least successful student
Exp- Years experience
Lang- Home language
L/I- Language of instruction
#G- Number of girls
2MSS- 2nd most successful student
2LSS- 2nd Least successful student

APPENDIX II

Raw data of teachers' responses, regarding boys, on the Attribution Interview and Sex-role Stereotype Questionnaire

	ATTRIBUTIONS: BOYS								BEST BOY STUDENT: CHARACTERISTICS																			
T	B1 MS	B1 MF	B2 MS	B2 MF	B3 LS	B3 LF	B4 LS	B4 LF	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
1	2	1	5	2	5	1	7	5	1	4	3	3	2	2	4	5	4	2	1	5	3	2	4	3	4	4	5	5
2	3	4	2	4	4	4	4	2	1	5	3	4	2	4	5	5	5	3	2	4	4	3	4	5	4	5	5	5
3	1	2	1	2	5	3	5	5	1	5	3	2	3	4	4	5	2	3	2	4	4	4	3	1	3	5	5	5
4	1	3	2	4	4	1	4	4	1	3	2	4	1	2	3	3	4	2	2	3	4	2	3	2	3	4	2	2
5	2	4	2	4	2	4	4	5	2	4	3	3	3	3	5	4	3	3	2	3	3	3	3	3	3	5	5	5
6	1	4	1	4	5	1	1	5	1	2	2	3	2	3	3	4	3	3	1	3	3	3	3	1	1	4	3	3
7	2	4	3	4	2	1	4	2	1	3	4	5	3	4	3	5	3	3	1	3	3	4	4	3	4	5	5	5
8	1	2	2	4	3	1	3	2	1	1	4	5	4	5	5	5	4	5	3	5	5	5	5	3	5	5	5	5
9	2	1	3	1	7	1	3	2	3	3	3	3	3	3	4	4	4	3	3	4	3	3	3	3	5	5	5	4
10	2	1	2	1	2	2	1	5	1	5	4	4	3	3	2	4	4	3	2	3	2	2	4	1	5	5	5	5
11	1	2	2	1	1	2	1	5	3	5	2	3	4	3	4	4	4	4	3	5	4	4	5	3	5	5	5	3
12	1	4	1	2	5	1	5	5	1	4	3	4	2	4	4	4	4	3	2	3	3	3	3	1	2	3	5	5
13	3	4	1	4	6	2	1	5	4	5	5	5	4	4	5	5	5	4	1	5	3	3	5	5	5	5	5	5
14	2	4	3	4	5	1	2	6	2	5	4	4	4	5	5	5	5	4	4	4	5	4	4	3	5	5	4	4
15	2	4	2	4	6	2	1	2	3	4	3	4	4	4	4	4	3	4	4	4	5	2	4	4	4	4	4	4
16	2	7	1	5	4	2	1	1	1	5	5	5	3	4	4	5	5	4	2	5	4	5	5	4	4	5	5	5
17	1	2	2	1	4	1	4	2	3	4	4	4	4	4	4	4	3	4	3	3	3	4	4	4	5	4	4	4
18	1	2	1	2	5	1	5	2	5	5	5	5	5	4	5	5	5	5	5	5	3	5	5	5	5	5	5	5
19	3	7	2	7	7	3	7	7	1	5	4	4	1	3	4	4	4	4	2	5	1	4	4	2	5	5	5	4

20	1	2	1	2	2	1	4	2	2	5	5	5	3	4	4	5	4	4	1	4	3	2	4	2	5	5	5	5
21	1	2	2	5	4	3	6	6	4	3	3	2	4	4	3	3	3	4	4	3	3	4	4	4	2	3	4	3
22	1	3	3	7	5	1	7	5	1	4	3	3	3	3	5	5	5	3	2	3	3	2	4	3	1	5	5	5
23	5	2	1	2	5	3	5	5	4	3	3	2	4	3	4	3	3	4	4	3	4	2	4	4	4	4	3	2
24	5	2	7	2	5	1	3	2	1	5	3	4	4	3	3	4	3	3	2	5	3	5	4	1	3	5	5	4
25	1	4	1	4	5	1	5	2	1	4	4	5	3	3	3	5	5	3	1	4	3	4	5	2	2	5	5	5
26	1	2	2	1	4	2	4	2	3	4	4	3	3	4	4	5	5	4	4	5	3	3	5	4	5	5	5	5
27	1	7	1	4	4	2	4	2	1	3	3	4	1	2	4	4	4	3	1	2	4	4	4	1	2	4	4	4
28	2	1	5	2	5	1	5	1	1	4	3	3	2	2	4	5	4	2	1	5	3	2	4	3	4	4	5	5
29	2	1	5	2	5	1	5	4	1	5	3	4	2	4	5	5	5	3	2	4	4	3	4	5	4	5	5	5
30	1	2	1	2	5	3	5	1	1	5	3	2	3	4	4	5	2	3	2	4	4	4	3	1	3	5	5	5
31	1	3	2	4	4	1	4	1	1	3	2	4	1	2	3	3	4	2	2	3	4	2	3	2	3	4	2	2
32	1	4	1	4	5	1	5	1	1	2	2	3	2	3	3	4	3	3	1	3	3	3	3	1	1	4	3	4
33	3	4	1	4	6	2	5	3	4	5	5	5	4	4	5	5	5	4	1	5	3	3	5	5	5	5	5	5
34	2	1	1	2	1	2	2	1	1	4	3	3	2	2	4	5	4	2	1	5	3	2	4	3	4	4	5	5
35	1	2	1	2	5	3	5	1	1	5	3	2	3	4	4	5	2	3	2	4	4	4	3	1	3	5	5	5
36	1	4	2	1	4	1	2	1	3	4	3	4	5	1	4	4	4	3	3	3	3	3	2	2	2	5	4	5
37	2	1	1	2	4	2	5	3	3	5	5	4	2	5	5	5	4	5	3	4	4	4	5	4	5	5	5	5
38	1	2	4	1	4	1	2	1	3	4	3	4	3	3	3	3	4	3	2	4	2	4	4	3	5	4	4	4
39	5	2	7	2	5	1	2	1	1	5	3	4	4	3	3	4	3	3	2	5	3	5	4	1	3	5	5	4
40	2	1	3	1	2	1	2	1	1	5	4	2	1	3	5	5	5	3	1	4	2	3	3	2	4	5	5	5

Keys: T - Teacher number
B1MS - Most successful boy: success
B1MF - Most successful boy: failure
B2MS - 2nd Most successful boy: success
B2MF - 2nd Most successful boy: failure
C1 - C20 - Characteristics
B3LS - Least successful boy: success
B3LF - Least successful boy: failure
B4LS - 2nd Least successful boy: success
B4LF - 2nd Least successful boy: failure

APPENDIX III

Raw data of teachers' responses, regarding girls, on the Attribution Interview and Sex-role Stereotype Questionnaire

	ATTRIBUTIONS: GIRLS								BEST GIRL STUDENT: CHARACTERISTICS																			
T	G1 MS	G1 MF	G2 MS	G2 MF	G3 LS	G3 LF	G4 LS	G4 LF	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C2
1	3	4	2	1	5	1	5	3	1	4	3	3	2	2	4	5	4	2	1	5	3	2	4	3	4	4	5	5
2	2	4	2	4	2	4	4	2	1	5	3	4	2	4	5	5	5	3	2	4	4	3	4	5	4	5	5	5
3	3	7	1	2	5	1	5	1	1	5	3	2	3	4	4	5	2	3	2	4	4	4	3	1	3	5	5	5
4	1	4	2	1	4	1	4	2	1	3	2	4	1	2	3	3	4	2	2	3	4	2	3	2	3	4	2	2
5	3	4	3	4	5	4	4	3	2	4	3	3	3	3	5	4	3	3	2	3	3	3	3	3	3	5	5	5
6	1	7	1	7	5	1	2	1	1	2	2	3	2	3	3	4	3	3	1	3	3	3	3	1	1	4	3	3
7	1	2	3	4	2	1	5	3	1	3	4	5	3	4	3	5	3	3	1	3	3	4	4	3	4	5	5	5
8	2	4	2	1	2	1	5	2	1	1	4	5	4	5	5	5	4	5	3	5	5	5	5	3	5	5	5	5
9	2	1	2	1	2	7	2	1	3	3	3	3	3	3	4	4	4	3	3	4	3	3	3	3	5	5	5	4
10	3	7	2	1	5	2	2	1	1	5	4	4	3	3	2	4	4	3	2	3	2	2	4	1	5	5	5	5
11	2	7	1	3	5	1	5	2	3	5	2	3	4	3	4	4	4	4	3	5	4	4	5	3	5	5	5	3
12	2	4	2	4	5	3	5	2	1	4	3	4	2	4	4	4	4	3	2	3	3	3	3	1	2	3	5	5
13	2	4	2	4	5	1	5	1	4	5	5	5	4	4	5	5	5	4	1	5	3	3	5	5	5	5	5	5
14	2	4	2	4	6	4	1	2	2	5	4	4	4	5	5	5	5	4	4	4	5	4	4	3	5	5	4	4
15	2	4	2	4	2	4	2	4	3	4	3	4	4	4	4	4	3	4	4	4	5	2	4	4	4	4	4	4
16	2	7	2	1	1	3	1	3	1	5	5	5	3	4	4	5	5	4	2	5	4	5	5	4	4	5	5	5
17	2	4	2	1	2	1	1	2	3	4	4	4	4	4	4	4	3	4	3	3	3	4	4	4	5	4	4	4
18	1	4	1	4	2	1	4	1	5	5	5	5	5	4	5	5	5	5	5	5	3	5	5	5	5	5	5	5
19	3	7	3	7	7	2	7	2	1	5	4	4	1	3	4	4	4	4	2	5	1	4	4	2	5	5	5	4

20	2	1	1	4	2	1	4	2	2	5	5	5	3	4	4	5	4	4	1	4	3	2	4	2	5	5	5	5
21	1	4	2	7	6	3	5	3	4	3	3	2	4	4	3	3	3	4	4	3	3	4	4	4	2	3	4	3
22	1	7	3	7	5	2	6	1	1	4	3	3	3	3	5	5	5	3	2	3	3	2	4	3	1	5	5	5
23	2	1	2	1	5	2	5	2	4	3	3	2	4	3	4	3	3	4	4	3	4	2	4	4	4	4	3	2
24	2	1	2	1	2	1	1	2	1	5	3	4	4	3	3	4	3	3	2	5	3	5	4	1	3	5	5	4
25	2	4	1	4	5	2	5	2	1	4	4	5	3	3	3	5	5	3	1	4	3	4	5	2	2	5	5	5
26	2	4	2	7	4	2	5	4	3	4	4	3	3	4	4	5	5	4	4	5	3	3	5	4	5	5	5	5
27	1	7	1	4	4	2	4	2	1	3	3	4	1	2	4	4	4	3	1	2	4	4	4	1	2	4	4	4
28	3	4	2	1	5	1	5	3	1	4	3	3	2	2	4	5	4	2	1	5	3	2	4	3	4	4	5	5
29	3	4	2	1	5	4	5	3	1	5	3	4	2	4	5	5	5	3	2	4	4	3	4	5	4	5	5	5
30	3	7	1	2	5	1	5	1	1	5	3	2	3	4	4	5	2	3	2	4	4	4	3	1	3	5	5	5
31	1	4	2	1	4	1	4	2	1	3	2	4	1	2	3	3	4	2	2	3	4	2	3	2	3	4	2	2
32	1	7	1	7	5	1	2	1	1	2	2	3	2	3	3	4	3	3	1	3	3	3	3	1	1	4	3	4
33	2	4	2	4	5	3	5	2	4	5	5	5	4	4	5	5	5	4	1	5	3	3	5	5	5	5	5	5
34	1	2	2	1	2	1	5	3	1	4	3	3	2	2	4	5	4	2	1	5	3	2	4	3	4	4	5	5
35	3	7	1	2	5	1	5	1	1	5	3	2	3	4	4	5	2	3	2	4	4	4	3	1	3	5	5	5
36	1	4	1	7	2	1	4	7	3	4	3	4	5	1	4	4	4	3	3	3	3	3	2	2	2	5	4	5
37	2	1	3	7	5	3	4	2	3	5	5	4	2	5	5	5	4	5	3	4	4	4	5	4	5	5	5	5
38	2	4	2	4	2	1	4	1	3	4	3	4	3	3	3	3	4	3	2	4	2	4	4	3	5	4	4	4
39	2	1	2	1	2	1	1	2	1	5	3	4	4	3	3	4	3	3	2	5	3	5	4	1	3	5	5	4
40	1	2	2	1	2	1	4	2	1	5	4	2	1	3	5	5	5	3	1	4	2	3	3	2	4	5	5	5

Keys: T - Teacher number
B1MS - Most successful boy: success
B1MF - Most successful boy: failure
B2MS - 2nd Most successful boy: success
B2MF - 2nd Most successful boy: failure
C1 - C20 - Characteristics
B3LS - Least successful boy: success
B3LF - Least successful boy: failure
B4LS - 2nd Least successful boy: success
B4LF - 2nd Least successful boy: failure

APPENDIX IV: AFRIKAANSE VRAELYS

NAVORSING VIR DIE GRAAD M.Ed (WISKUNDE)
UNIVERSITEIT VAN KAAPSTAD

NAVORSER: ROSE ROELOFSE

Afdeling A

Beantwoord asseblief die volgende vrae of omkring die regte keuse in elk van die volgende vrae:

Geslag van onderwyser: Manlik Vroulik

Jare onderwys-ervaring: _____

Ouderdom van onderwyser: _____

Moedertaal van onderwyser: Engels / Afrikaans / Ander

(noem)_____

Skool: Seunskool / Meisieskool / Ko-ed

Onderrigtaal: Engels / Afrikaans / Ander (noem)_____

Aantal leerlinge in u st.7 groep: _____

Aantal seuns: _____

Aantal meisies: _____

LET WEL :- **Die vraelys het slegs betrekking op die st.7 leerlinge wat deur u onderrig word**

AFDELING B1

1. Noem die mees suksesvolle wiskunde leerling in u klas:_____

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student suksesvol is in die aanleer van wiskundige begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student misluk / probleme ondervind met die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

2. Noem die tweede mees suksesvolle leerling in u klas:_____

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student suksesvol is in die aanleer van wiskundige begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student misluk / probleme ondervind met die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

3. Indien beide no. 1 & 2 seuns is, noem die mees suksesvolle meisie in die klas:

_____

OF

Indien beide no. 1 & 2 meisies is, noem die mees suksesvolle seun in die klas:

_____

OF

Indien no. 1 & 2 'n seun en 'n meisie is, noem die tweede mees suksesvolle meisie in die klas: _____

Kies uit die onderstaande lys die **belangrikste rede,** volgens u mening, waarom die student suksesvol is in aanleer van wiskundige begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangrikste rede,** volgens u mening, waarom die student misluk / probleme ondervind met die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

4. Indien twee meisies en een seun se name reeds genoem is, noem die tweede mees suksesvolle seun in die klas: _____

OF

Indien twee seuns en een meisie reeds genoem is, noem die tweede mees suksesvolle meisie in die klas: _____

Kies uit die onderstaande lys die **belangrikste rede,** volgens u mening, waarom die student suksesvol is in die aanleer van wiskundige begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangriste rede,** volgens u mening, waarom die student misluk / probleme ondervind in die aanleer die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

AFDELING B2

1. Noem die leerling in u klas wat die swakste in wiskunde presteer het:_____

Kies uit die onderstaande lys die **belangrikste rede,** volgens u mening, waarom die student suksesvol is in die aanleer van wiskundige begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangrikste rede,** volgens u mening, waarom die student misluk / probleme ondervind in die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

2. Noem die tweede swakste wiskunde leerling in u klas:_____

Kies uit die onderstaande lys die **belangrikste rede,** volgens u mening, waarom die student suksesvol is in die aanleer van wiskunde begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangrikste rede,** volgens u mening, waarom die student misluk / probleme ondervind in die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

3. Indien beide no. 1 & 2 seuns is, noem die meisie in die klas wat die swakste presteer in wiskunde: _____

OF

Indien beide no. 1 & 2 meisies is, noem die seun in die klas wat die swakste presteer in wiskunde: _____

OF

Indien no. 1 & 2 'n seun en 'n meisie is, noem die tweede minste suksesvolle meisie in die klas: _____

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student suksesvol is in die aanleer van wiskundige begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student misluk / probleme ondervind in die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

4. Indien twee meisies en een seun se name reeds genoem is, noem die seun in die klas wat die tweede swakste in wiskunde is:

_____

OF

Indien twee seuns en een meisie reeds genoem is, noem die meisie in die klas wat die tweede swakste in wiskunde is: _____

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student suksesvol is in die aanleer van wiskundige begrippe

Sukses Kategorie	
Vermoë	
Toewyding	
Intrinsieke motivering	
Take is maklik	
Hulp van onderwyser	
Hulp van ander	
Ander redes	

Kies uit die onderstaande lys die **belangrikste rede**, volgens u mening, waarom die student misluk / probleme ondervind in die aanleer van wiskundige begrippe

Probleme/Mislukking Kategorie	
Gebrek aan vermoë	
Gebrek aan toewyding	
Gebrek aan intrinsieke motivering	
Take te moeilik	
Gebrek aan hulp van onderwyser	
Gebrek aan hulp van ander	
Ander redes	

AFDELING C

In die volgende tabel moet u asseblief by elkeen van die items 'n keuse maak, wat volgens u mening, die mees verteenwoordigende evaluasie sal wees omtrent die mees suksesvolle seun en meisie in u wiskunde klas. Die skaal loop van 1 tot 5 waar 1 beteken dat u 'n baie sterk ooreenkoms sien met die linkerkant se frase en 5 beteken 'n baie sterk ooreenkoms met die regterkantste frase. Kies enige waarde van 1 tot 5 om u oordeel aan te dui. Onthou asseblief dat dit u persepsie van die student is, en nie sy eie nie!

C.1

Item	**Mees suksesvolle SEUN ...**						
1	is nie aggressief	1	2	3	4	5	is baie aggressief
2	is nie onafhanklik	1	2	3	4	5	is baie onafhanklik
3	is baie subjektief	1	2	3	4	5	is baie objektief
4	is maklik beïnvloedbaar	1	2	3	4	5	is nie maklik beïnvloedbaar nie
5	is baie onderdanig	1	2	3	4	5	is baie dominerend
6	is baie passief	1	2	3	4	5	is baie aktief
7	is glad nie kompeterend	1	2	3	4	5	is baie kompeterend
8	is baie onlogies	1	2	3	4	5	is baie logies
9	is baie indirek	1	2	3	4	5	is baie direk
10	is glad nie avontuurlustig	1	2	3	4	5	is baie avontuurlustig
11	is baie stil	1	2	3	4	5	is baie raserig
12	Het 'n probleem om besluite te neem	1	2	3	4	5	Neem maklik besluite
13	Tree byna nooit as leier op nie	1	2	3	4	5	Tree byna altyd op as leier
14	het 'n groot behoefte aan sekuriteit	1	2	3	4	5	het min behoefte aan sekuriteit
15	is glad nie selfversekerd	1	2	3	4	5	is baie selfversekerd
16	is baie ongemaklik om aggressief te wees	1	2	3	4	5	is nie ongemaklik om aggressief te wees nie
17	Gee selde antwoorde op wiskunde probleme uit vrye wil	1	2	3	4	5	Gee maklik antwoorde uit vrye wil
18	Geniet nie wiskunde baie nie	1	2	3	4	5	Geniet wiskunde baie
19	is baie afhanklik van ander in wiskunde	1	2	3	4	5	is baie onafhanklik van ander in wiskunde
20	Volhard nie met moeilike wiskunde probleme nie	1	2	3	4	5	Volhard met moeilike wiskunde probleme

C.2

Item	Mees suksesvolle MEISIE ...						
1	is nie aggressief	1	2	3	4	5	is baie aggressief
2	is nie onafhanklik	1	2	3	4	5	is baie onafhanklik
3	is baie subjektief	1	2	3	4	5	is baie objektief
4	is maklik beïnvloedbaar	1	2	3	4	5	is nie maklik beïnvloedbaar nie
5	is baie onderdanig	1	2	3	4	5	is baie dominerend
6	is baie passief	1	2	3	4	5	is baie aktief
7	is glad nie kompeterend	1	2	3	4	5	is baie kompeterend
8	is baie onlogies	1	2	3	4	5	is baie logies
9	is baie indirek	1	2	3	4	5	is baie direk
10	is glad nie avontuurlustig	1	2	3	4	5	is baie avontuurlustig
11	is baie stil	1	2	3	4	5	is baie raserig
12	Het 'n probleem om besluite te neem	1	2	3	4	5	Neem maklik besluite
13	Tree byna nooit as leier op nie	1	2	3	4	5	Tree byna altyd op as leier
14	het 'n groot behoefte aan sekuriteit	1	2	3	4	5	het min behoefte aan sekuriteit
15	is glad nie selfversekerd	1	2	3	4	5	is baie selfversekerd
16	is baie ongemaklik om aggressief te wees	1	2	3	4	5	is nie ongemaklik om aggressief te wees nie
17	Gee selde antwoorde op wiskunde probleme uit vrye wil	1	2	3	4	5	Gee maklik antwoorde uit vrye wil
18	Geniet nie wiskunde baie nie	1	2	3	4	5	Geniet wiskunde baie
19	is baie afhanklik van ander in wiskunde	1	2	3	4	5	is baie onafhanklik van ander in wiskunde
20	Volhard nie met moeilike wiskunde probleme nie	1	2	3	4	5	Volhard met moeilike wiskunde probleme

Baie dankie vir u deelname aan my navorsing

APPENDIX V: ENGLISH QUESTIONNAIRE

RESEARCH FOR THE DEGREE M.Ed (MATHEMATICS)
UNIVERSITY OF CAPE TOWN

RESEARCHER: ROSE ROELOFSE

SECTION A

Please answer the following questions or mark the right choice with a circle in each of the following questions:

Gender of teacher : Male Female

Years of teaching experience: _____

Age of teacher: _____

Home language of teacher: English / Afrikaans / Other

School: Boys / Girls / Co-educational

Language of instruction: English / Afrikaans / Other

Number of std. 7 pupils in the group: _____

Number of boys: _____

Number of girls: _____

Please note: This questionnaire is only about std.7 (grade 9) students taught by you

SECTION B1

1. Name the most successful mathematics student in your class:

_____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from teacher	
Help from other	
Other reasons	

Select the **major reason** why you think the student had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from other	
Other reasons	

2. Name the second most successful mathematics student in your class:

_____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from teacher	
Help from others	
Other reasons	

Select the **major reason** why you think the student had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from others	
Other reasons	

3. If both no.1 & 2 are girls, name the most successful boy in your class: _____

OR

If both no.1 & 2 are boys, name the most successful girl in your class: _____

OR

If no.1 & 2 are a boy and a girl, name the second most successful girl in your class: _____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from Teacher	
Help from others	
Other reasons	

Select the **major reason** why the student had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from others	
Other reasons	

4. Name the second most successful boy or girl (so that your total selection will be two boys and two girls): _____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from Teacher	
Help from others	
Other reasons	

Select the **major reason** why you think the student had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from others	
Other reasons	

SECTION B2

1. Name the least successful mathematics student in your class:

_____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from teacher	
Help from others	
Other reasons	

Select the **major reason** why you think the had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from others	
Other reasons	

2. Name the second least successful mathematics student in your class:

_____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from teacher	
Help from other	
Other reasons	

Select the **major reason** why you think the student had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from others	
Other reasons	

3. If no.1 & 2 are both girls, name the least successful boy in your class: _____

OR

If no.1 & 2 are both boys, name the least successful girl in your class: _____

OR

If no.1 & 2 are a boy and a girl, name the second least successful girl in your class: _____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from teacher	
Help from others	
Other reasons	

Select the **major reason** why you think the student had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from others	
Other reasons	

4. Name the second least successful boy or girl (so that your total selection will be two boys and two girls): _____

Select the **major reason** why you think the student succeeded in learning mathematical concepts

Success Category	
Ability	
Effort	
Intrinsic motivation	
Task	
Help from teacher	
Help from others	
Other reasons	

Select the **major reason** why you think the student had difficulty/failed in learning mathematical concepts

Difficulty/Failure Category	
Lack of Ability	
Lack of Effort	
Lack of Intrinsic motivation	
Task	
Lack of help from teacher	
Lack of help from others	
Other reasons	

SECTION C

In the following table you must respond to each item by selecting a value from 1 to 5 as follows: you must select the number that you believe agrees the best with your best boy and best girl mathematics student's characteristics: 1 means total agreement with the left hand phrase to 5 that means total agreement with the right hand phrase. This is only about the **best boy and best girl** mathematics student. Remember that it is your belief about the student, and not his/her own!

C1

Item	The most successful BOY mathematics student …						
1	..is not aggressive	1	2	3	4	5	..is very aggressive
2	..is not independent	1	2	3	4	5	..is very independent
3	..is very subjective	1	2	3	4	5	..is very objective
4	..is very easily influenced	1	2	3	4	5	..is not easily influenced
5	..is very submissive	1	2	3	4	5	..is very dominant
6	..is very passive	1	2	3	4	5	..is very active
7	..is not at all competitive	1	2	3	4	5	..is very competitive
8	..is very illogical	1	2	3	4	5	..is very logical
9	..is very indirect	1	2	3	4	5	..is very direct
10	..is not at all adventurous	1	2	3	4	5	..is very adventurous
11	.. is very quiet	1	2	3	4	5	..is very loud
12	..has difficulty making decisions	1	2	3	4	5	Makes decisions easily
13	..almost never acts as leader	1	2	3	4	5	..almost always acts as leader
14	..has a very strong need for security	1	2	3	4	5	..has very little need for security
15	..is not at all self-confident	1	2	3	4	5	..is very self-confident
16	..is very uncomfortable about being aggressive	1	2	3	4	5	..is not uncomfortable about being aggressive
17	..seldom volunteers answers to mathematics problems	1	2	3	4	5	..often volunteers answers to mathematics problems
18	..does not enjoy mathematics very much	1	2	3	4	5	..enjoys mathematics very much
19	..is very dependent in mathematics	1	2	3	4	5	..is very independent in mathematics
20	..does not persist with hard mathematical tasks	1	2	3	4	5	..is very persistent with hard mathematical tasks

C2

Item	The most successful GIRL mathematics student…						
1	..is not aggressive	1	2	3	4	5	..is very aggressive
2	..is not independent	1	2	3	4	5	..is very independent
3	..is very subjective	1	2	3	4	5	..is very objective
4	..is very easily influenced	1	2	3	4	5	..is not easily influenced
5	..is very submissive	1	2	3	4	5	..is very dominant
6	..is very passive	1	2	3	4	5	..is very active
7	..is not at all competitive	1	2	3	4	5	..is very competitive
8	..is very illogical	1	2	3	4	5	..is very logical
9	..is very indirect	1	2	3	4	5	..is very direct
10	..is not at all adventurous	1	2	3	4	5	..is very adventurous
11	..is very quiet	1	2	3	4	5	..is very loud
12	..has difficulty making decisions	1	2	3	4	5	..makes decisions easily
13	..almost never acts as leader	1	2	3	4	5	..almost always acts as leader
14	..has a very strong need for security	1	2	3	4	5	..has very little need for security
15	..is not at all self-confident	1	2	3	4	5	..is very self-confident
16	..is very uncomfortable about being aggressive	1	2	3	4	5	..is not uncomfortable about being aggressive
17	..seldom volunteers answers to mathematics problems	1	2	3	4	5	..often volunteers answers to mathematics problems
18	..does not enjoy mathematics very much	1	2	3	4	5	..enjoys mathematics very much
19	..is very dependent in mathematics	1	2	3	4	5	..is very independent in mathematics
20	..does not persist with hard mathematical tasks	1	2	3	4	5	..is very persistent on hard mathematical tasks

Thank you for taking part in my research project.

ELIZABETH FENNEMA, PENELOPE L. PETERSON,
THOMAS P. CARPENTER, AND CHERYL A. LUBINSKI

TEACHERS' ATTRIBUTIONS AND BELIEFS ABOUT GIRLS, BOYS, AND MATHEMATICS

ABSTRACT. Thirty-eight first grade teachers were asked to identify their two most and least successful girls and boys in mathematics, to attribute causation of these students' successes and failures, and to describe their characteristics. Teachers' choices of most and least successful students were compared to mathematics test scores of their students. Teachers were most inaccurate when selecting most successful boys. Teachers tended to attribute causation of boys' successes and failures to ability and girls' successes and failures to effort. Teachers thought their best boy students when compared to their best girl students, were more competitive, more logical, more adventurous, volunteered answers more often to mathematics problems, enjoyed math more, and were more independent in mathematics.

Gender differences in outcomes of mathematics education constitutes a pervasive educational inequity that manifests itself in superior performance by boys in high cognitive level mathematics tasks (Hyde, Fennema and Lamon, in press), in more negative personal belief systems about mathematics by girls, and in under-participation of females in mathematics-related careers (see Fennema, 1987; Shuard, 1986 for a complete review). Although many factors contribute to the development of these gender differences in mathematics, there is no doubt that schools are major influences. Among the various dimensions of schools that have been investigated as partial explanations for these differences are stereotypes in textbooks (Northam, 1986), teacher attention during mathematics instruction (Leder, 1987), student engagement in mathematical tasks (Fennema and Peterson, 1987), and the structure and organization of classrooms (Hallinan and Sorensen, 1987). While each of these lines of research has added to our knowledge about the influence of important educational components, little is known about teachers' attributions and beliefs about girls, boys, and mathematics, and the influence of these beliefs on learning.

Teachers' beliefs are important and the Autonomous Learning Behavior Model, which was proposed by Fennema and Peterson (1985) as an explanation of gender differences in mathematics, hypothesizes the relationship between teachers' beliefs and gender differences. This model, shown in Figure 1, indicates that one component of the external influences which effect the development of gender differences, is teacher influence on both students' internal motivational beliefs and on students' participation in

Educational Studies in Mathematics **21**: 55–69, 1990.

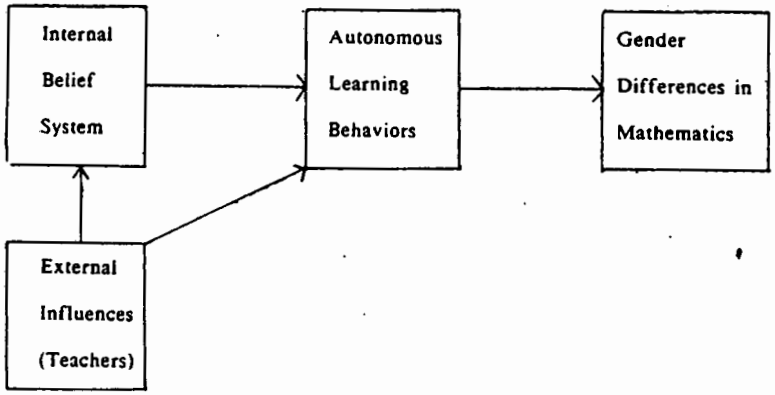


Fig. 1. Autonomous learning behavior model.

classroom learning activities. Teachers' instructional decisions, through which this influence is transmitted, are mediated by teachers' beliefs (Peterson, Fennema, Carpenter, and Loef, 1989). These decisions influence what learners do in classrooms which in turn influences their learning. This is not a new idea. In an extensive review of the literature, Clark and Peterson concluded that "a teacher's cognitive and other behaviors are guided by and make sense in relation to a personally held system of beliefs" (Clark and Peterson, 1986, p. 207).

Studies of teachers' beliefs have investigated teachers' general conceptions of their roles (Janesicki, 1977; Munby, 1983), their general beliefs about curriculum (Bussis, Chittenden, and Amarel, 1976) and the general principles used to explain their own interactive behavior (Connors, 1978; Marland, 1977). Others have examined teachers' beliefs about the nature of mathematics and its impact on curriculum (Skemp, 1978; Thompson, 1982). What has not been investigated is whether or not teachers hold different beliefs about girls, boys, and mathematics. The study reported here focused on the identification of successful/unsuccessful mathematics students and the accuracy of this identification; teachers' attributions of the causes of successes and failures of girls and boys; and teachers' beliefs about the characteristics of their best girl and boy mathematics students.

Teachers' beliefs about, or attributions of, causation of their students' achievement successes and failures are receiving increasing attention by researchers. (See Weiner, 1979, for a discussion of attribution theory.) Clark and Peterson (1986) state that "the most important beliefs that

teachers have about students are those that deal with the teachers' perception of the causes of students' behavior" (p. 28). A teacher's causal attributions are important because perceptions of why his/her students succeed or fail in achievement situations has an impact on the teacher's expectancies for students' future achievement success (Cooper, 1979; Bar-Tal and Guttmann, 1981; Peterson and Barger, 1985). In addition, when a teacher believes that she/he has some control over students' learning, the teacher feels more responsibility to see that the student learns (Guskey, 1982). While most of the research has been done with students' attributions of their own successes and failures, Peterson and Barger (1985), in synthesizing the literature, argue convincingly that the attributions which teachers make about the cause of their students' successes and failures make a major contribution to the forming of expectancies that teachers hold for students' learning. Lorenz (1982) does provide evidence that teachers may attribute girls' and boys' successes in mathematics to different causes.

Teachers' attributions influence students' attributions through teacher behavior. Graham (1984) reports evidence that indicates that when a teacher exhibits sympathy with what is perceived as failure, students are lead to believe that the failure was due to a nonchangeable cause such as ability. When a teacher exhibits anger in the same situation, students are led to believe that the failure should have been avoided and thus, was due to a nonstable factor over which the students have some control.

Peterson and Clark (1986) concluded that the sex of a student has not been shown to be a significant factor affecting teachers' attributions. However, a close reading of the literature shows that most studies dealing directly with teacher attributions have not included gender as a variable. In addition, there is reason to believe that gender of student should be an important variable in teacher attributions. There is some evidence that teachers hold different beliefs about appropriate learning experiences for boys and girls. Leinhardt, Seewald, and Engel (1979) reported that teachers had more academic contacts with boys than with girls in mathematics (a subject often stereotyped as masculine) and more academic contacts with girls than boys in reading (a subject stereotyped as feminine). While other studies have reported that teachers do not have lower expectations for girls' performance in mathematics than they do for boys' performance, teachers have been found to provide more encouragement for boys than for girls to learn mathematics (Stage et al., 1985).

Causal attribution has been investigated often as it relates to gender differences in achievement. Although there is some disagreement about the size of the differences (Frieze, Whitley, Hanusa, and McHugh, 1982), many

studies have reported that females and males tend to exhibit different attributional patterns (Bar-Tal and Frieze, 1977; Deaux, 1976). In a somewhat simplistic summary, males tend to attribute successes to an internal stable cause (ability), and failure to an external, unstable cause (effort). Females tend to attribute successes to unstable causes (effort and luck) and failures to ability. This pattern of attributions has been shown to occur in general achievement situations as well as in the specific achievement situation of mathematics (Wolleat et al., 1980).

Thus, while there appears to be consensus that teachers' attributions and beliefs are important, their beliefs in relation to gender and mathematics are unclear. Information about teachers' attributions and beliefs in relation to gender and mathematics was gathered in this study by addressing the following questions:

1. Who do teachers believe are their most and least successful students: girls or boys?
2. How accurate are teachers in selecting their most successful and least successful mathematics students?
3. Do teachers attribute causation of success and failure experiences differently for girls and boys?
4. Do teachers believe that there are differences in the characteristics of their best girl and best boy mathematics students?

METHOD

Subjects

The subjects for this study were 38 first-grade, female teachers in 24 schools in the U.S. The mean number of years of teaching elementary school for the teachers in the sample was 10.9 and the mean number of years teaching first grade was 5.6. Two of the teachers were in their first year of teaching. These 38 teachers taught 368 first-grade boys and 314 first-grade girls in classrooms that varied in the number of first graders from 6 to 27. Some of the teachers also taught second-grade children in combined first/second grade classrooms. Only data about first-grade children are included here.

Data Gathering Procedures

Teachers' attributions and beliefs. Information relative to beliefs about successful/unsuccessful students and attribution of causation of success or failure was gathered in April in a structured, individual *Attribution Interview*. During this interview, each teacher was first asked to name the most successful mathematics student (MS) in her class. She was then shown an index card with the following attribution categories listed:

Student's ability	Easiness of the task
Student's effort	Teacher helped
Student's intrinsic motivation	Others helped (e.g. parents or peers)
Good luck	

Four of these (ability, effort, task, and luck) reflect Weiner's (1974) categories and are common to many studies of teachers' attributions (Prawat, Byers, and Anderson, 1983; Cooper and Burger, 1980). The two help categories (teacher and other) were selected because it has been hypothesized that females, more than males, fail to become independent learners of mathematics (Fennema and Peterson, 1985) and learn to rely on others when faced with mathematical difficulties.

From the list of attributional categories, the teacher was asked to pick the major reason why the student succeeded in learning mathematics. The same procedure was followed for the teacher's selecting of the major reason why the student had trouble learning a mathematical idea. (The attributions were changed to failure categories such as "Student's lack of ability.") After the teacher had gone through this procedure for the first student she had selected, she was asked to select her next most successful mathematics student and to respond to the same set of questions. After the teacher had selected and responded about two of her students, the interviewers were trained to ask a third and fourth set of questions so that each teacher would respond about two girls and two boys. In the same fashion, teachers were asked to identify students (two girls and two boys) who had the most trouble in mathematics and then asked to identify causes for their successes and failures.

Information about teachers' beliefs concerning the characteristics of their best mathematics students was collected using a *Sex-role Stereotype Questionnaire* which was an adaptation of the Broverman et al. (1970) Sex-Role Stereotype Questionnaire. Sixteen descriptors, which seemed to be relevant to mathematical behavior, were selected from the original questionnaire. Four descriptors were added because of their direct relationship to classroom mathematical behavior: "Seldom volunteers answers to mathematics problems/Often volunteers answers to mathematics problems;" "Does not enjoy mathematics very much/Enjoys mathematics very much;" "Very dependent in mathematics/Very independent in mathematics;" and "Does not persist on hard mathematics tasks/Very persistent on hard mathematics tasks."

studies have reported that females and males tend to exhibit different attributional patterns (Bar-Tal and Frieze, 1977; Deaux, 1976). In a somewhat simplistic summary, males tend to attribute successes to an internal stable cause (ability), and failure to an external, unstable cause (effort). Females tend to attribute successes to unstable causes (effort and luck) and failures to ability. This pattern of attributions has been shown to occur in general achievement situations as well as in the specific achievement situation of mathematics (Wolleat et al., 1980).

Thus, while there appears to be consensus that teachers' attributions and beliefs are important, their beliefs in relation to gender and mathematics are unclear. Information about teachers' attributions and beliefs in relation to gender and mathematics was gathered in this study by addressing the following questions:

1. Who do teachers believe are their most and least successful students: girls or boys?
2. How accurate are teachers in selecting their most successful and least successful mathematics students?
3. Do teachers attribute causation of success and failure experiences differently for girls and boys?
4. Do teachers believe that there are differences in the characteristics of their best girl and best boy mathematics students?

METHOD

Subjects

The subjects for this study were 38 first-grade, female teachers in 24 schools in the U.S. The mean number of years of teaching elementary school for the teachers in the sample was 10.9 and the mean number of years teaching first grade was 5.6. Two of the teachers were in their first year of teaching. These 38 teachers taught 368 first-grade boys and 314 first-grade girls in classrooms that varied in the number of first graders from 6 to 27. Some of the teachers also taught second-grade children in combined first/second grade classrooms. Only data about first-grade children are included here.

Data Gathering Procedures

Teachers' attributions and beliefs. Information relative to beliefs about successful/unsuccessful students and attribution of causation of success or failure was gathered in April in a structured, individual *Attribution Interview*. During this interview, each teacher was first asked to name the most successful mathematics student (MS) in her class. She was then shown an index card with the following attribution categories listed:

Student's ability	Easiness of the task
Student's effort	Teacher helped
Student's intrinsic motivation	Others helped (e.g. parents or peers)
Good luck	

Four of these (ability, effort, task, and luck) reflect Weiner's (1974) categories and are common to many studies of teachers' attributions (Prawat, Byers, and Anderson, 1983; Cooper and Burger, 1980). The two help categories (teacher and other) were selected because it has been hypothesized that females, more than males, fail to become independent learners of mathematics (Fennema and Peterson, 1985) and learn to rely on others when faced with mathematical difficulties.

From the list of attributional categories, the teacher was asked to pick the major reason why the student succeeded in learning mathematics. The same procedure was followed for the teacher's selecting of the major reason why the student had trouble learning a mathematical idea. (The attributions were changed to failure categories such as "Student's lack of ability.") After the teacher had gone through this procedure for the first student she had selected, she was asked to select her next most successful mathematics student and to respond to the same set of questions. After the teacher had selected and responded about two of her students, the interviewers were trained to ask a third and fourth set of questions so that each teacher would respond about two girls and two boys. In the same fashion, teachers were asked to identify students (two girls and two boys) who had the most trouble in mathematics and then asked to identify causes for their successes and failures.

Information about teachers' beliefs concerning the characteristics of their best mathematics students was collected using a *Sex-role Stereotype Questionnaire* which was an adaptation of the Broverman et al. (1970) Sex-Role Stereotype Questionnaire. Sixteen descriptors, which seemed to be relevant to mathematical behavior, were selected from the original questionnaire. Four descriptors were added because of their direct relationship to classroom mathematical behavior: "Seldom volunteers answers to mathematics problems/Often volunteers answers to mathematics problems;" "Does not enjoy mathematics very much/Enjoys mathematics very much;" "Very dependent in mathematics/Very independent in mathematics;" and "Does not persist on hard mathematics tasks/Very persistent on hard mathematics tasks."

Teachers responded to each item on a Likert scale which ranged from 5 (which indicated high agreement with the right-hand phrase) to 1 (high agreement with the left-hand phrase). The 20 items that were used are listed in Table 4.

Mathematics learning. Mathematics learning was measured by a group-administered three-part test. The *Fact* test which was timed for two minutes, included 20 addition and subtraction basic number facts. The *Problem Solving-Regular* test included nine addition and subtraction word problems representing a range of problem types. The *Problem Solving-Extension* test consisted of four problems involving several operations or extraneous numbers, and four problems involving grouping and partitioning (see Carpenter, Fennema, Peterson, and Carey, 1988, for a complete description). Each problem in both problem-solving tests was printed on a separate page of a test booklet. The problems were read to the students by a trained tester, and students were instructed when to turn to the next page. Number of correct responses to all three parts of the test became the achievement scores.

RESULTS

Mathematics Learning

In Table I, the achievement scores are listed by sex and test. Although boys did not score significantly higher than did the girls on the Fact and Problem Solving-Regular tests, they did score significantly higher on the Problem Solving-Extension test. The Fact items probably corresponded most closely to the mathematics curriculum of the first grade. The Problem Solving-Extension items are not usually taught at all in the first grade. Thus, the

TABLE I

Mathematics achievement

Test	Girl		Boy		
	Mean	SD	Mean	SD	*t*
Fact	11.0	4.8	11.4	5.2	.99
Problem Solving (Regular)	6.6	2.1	6.8	2.1	1.07
Problem Solving (Extension)	3.8	2.2	4.3	2.3	2.87**

$n = 314$ girls, 368 boys.
$^{**}p \leq .004$.

gender differences in mathematics that were most apparent were in items that probably did not reflect direct instruction by the teacher and may have required more autonomous learning by the students.

Most/Least Successful Students

During the Attribution Interview 8% of the teachers chose no boys for their free choice selections of most successful math students while 45% of the teachers chose no girls. A boy was selected first as most successful 79% of the time, and a boy was selected second 58% of the time. When choosing least successful mathematics students, 82% of teachers chose at least one boy while 61% of the teachers chose at least one girl. Thus, boys tended to be chosen more often as both most and least successful mathematics students. Table II shows the accuracy of the choice of most/least successful students. These scores were constructed by counting the number of times a teacher freely selected as most or least successful a student whose score on the total test was in the top two or last two in class. (In the case of tied scores, all with the same high/low score were included.)

The teachers were accurate in their selection of most and least successful students more than half of the time (68 accurate choices, 58 inaccurate choices). Gender differences were not apparent in choice of least successful students. However, with most successful students, teachers were more accurate with girls than with boys (13 inaccurate choices of girls vs. 24 inaccurate choices of boys). These teachers appeared to have more accurate knowledge of achievement of highly successful girls than of highly successful boys.

Attribution

Table III shows the percentage of teachers' attributions to various categories for most (MS) and least (LS) sucessful girls and boys. Successes of MS

TABLE II

Accuracy of choice of most/least successful students

Accurate Choices	68	
Inaccurate Choices of Girls	23	(10 least, 13 most)
Inaccurate Choices of Boys	35	(11 least, 24 most)

Missing data = 22.
$n = 37$ teachers (1 teacher's data missing from this analysis).

TABLE III

Percentage of teachers' attributions to various categories[1]

	Most Successful Students				Least Successful Students			
	Success		Failure[2]		Success		Failure	
Category	Girl %	Boy %	Girl %	Boy %	Girl %	Boy %	Girl %	Boy %
Ability	33	58	8	3	9	8	29	22
Effort	37	12	24	25	32	24	28	33
Intrinsic Motivation	18	25	4	3	12	11	8	12
Task	3	1	40	45	16	21	28	20
Teacher Help	7	4	16	16	24	35	3	13
Others Help	3	0	0	1	5	1	1	0[3]
Other Causes	0	0	9	8	2	0	4	9

[1]Total attributions = 76 per sex.
[2]In case of failure, each category was prefaced by "lack of" or "hardness of."
[3]Missing data = 1.

girls/boys were respectively attributed to: Ability, 33% and 58%; Effort, 37% and 12%; Intrinsic Motivation, 18% and 25%; and Help (both Teacher and Other), 10% and 4%. MS girls' successes were attributed about equally to ability and effort while MS boys' successes were attributed predominantly to ability. Differences between teachers' attributions of MS girls' and boys' failure appeared minimal with the exception of attribution to task, which was chosen about half of the time: boys, 45% and girls, 40%. One should keep in mind that these particular boys and girls would seldom fail so teachers would not think that lack of ability would explain failure.

TABLE IV

Adjective checklist: descriptive statistics and t-tests by item

Item	Best Boy Student Mean	Best Boy Student SD	Best Girl Student Mean	Best Girl Student SD	$t_{(37)}$
1. Not aggressive/Very aggressive[1]	2.68	1.45	2.61	1.33	.27
2. Not independent/Very independent	3.95	1.01	4.26	.83	−1.53
3. Very subjective/Very objective	3.79	.91	3.34	1.05	1.86
4. Very easily influenced/Not easily influenced	3.95	.84	3.76	1.05	.85
5. Very submissive/Very dominant	3.79	.84	3.63	1.05	.76
6. Very passive/Very active	3.89	1.03	3.71	1.11	.79
7. Not at all competitive/Very competitive	4.11	1.01	3.68	1.09	2.25*
8. Very illogical/Very logical	4.55	.65	4.21	.78	2.59*
9. Very indirect/Very direct	3.89	.89	3.68	1.14	1.07
10. Not at all adventurous/Very adventurous	3.66	1.15	3.26	1.03	2.16*
11. Very quiet/Very loud	3.21	1.12	2.76	1.15	1.82
12. Has difficulty making decisions/Makes decisions easily	3.89	.98	4.11	.89	−1.11
13. Almost never acts as leader/Almost always acts as leader	3.55	1.13	3.45	1.03	.43
14. Very strong need for security/Very little need for security	2.92	1.12	3.13	1.19	−.84
15. Not at all self-confident/Very self-confident	3.84	.86	3.89	.98	−.25
16. Very uncomfortable about being aggressive/ Not uncomfortable about being aggressive	3.18	1.18	3.18	1.37	.00
17. Seldom volunteers answers to mathematics problems/ Often volunteers answers to mathematics problems	4.66	.94	4.08	1.34	2.77**
18. Does not enjoy mathematics very much/ Enjoys mathematics very much	4.89	.31	4.47	.65	3.60**
19. Very dependent in mathematics/ Very independent in mathematics	4.74	.60	4.29	.87	2.90**
20. Does not persist on hard mathematics tasks/ Very persistent on hard mathematics tasks	4.13	1.04	3.97	.75	.81

[1]Score above 2.50 indicates more agreement with the phrase on the right.
*$p < .05$. **$p < .01$.

When attributions of LS students' success were made, interesting contrasts are seen in several categories, when girls' scores are compared to boys: Effort, 32% vs. 24%; Task, 16% vs. 21%; Teacher Help, 24% vs. 35%; Others Help, 5% vs. 1%. In the case of failure of LS students, girl-boy contrasts were: Ability, 29% vs. 22%; Effort, 28% vs. 33%; and Task, 28% vs. 20%.

Adjective Check List

Descriptive statistics and *t*-tests of teachers' responses on each of the phrases on the Adjective Check List are in Table IV. Teachers gave significantly different ratings for girls and boys on the following phrases: Not at all competitive/very competitive; Very illogical/very logical; Not at all adventurous/very adventurous; Seldom volunteers answers to mathematics problems/often volunteers answers to mathematics problems; Does not enjoy mathematics very much/enjoys mathematics very much; Very dependent in mathematics/very independent in mathematics. In each case, teachers indicated that the phrase on the right was more descriptive of boys than of girls.

Another way to look at the responses on the Adjective Check List is to examine those phrases which received that highest and lowest ratings for girls and for boys. The highest ratings for boys were: Enjoys math, independent in math, volunteers answers to math, logical, persistent in math, and competitive. The highest ratings for girls were very similar: Enjoys math, independent in math, independent, logical, volunteers answers to math, and persistent in math. Teachers rated boys higher on all of these. The four lowest ratings for both boys and girls included aggressive, need for security, not uncomfortable with being aggressive, loud. No significant differences were found in the size of the response for these items. While teachers often gave their best boy math students significantly higher ratings than their best girl math students, they apparently saw many of the same traits in their best girl and boy students.

CONCLUSIONS AND DISCUSSION

There were gender differences in mathematics achievement in these Grade 1 students. While differences were not large, they appear to be educationally important because of their foreshadowing of differences that have been reported at later ages (Dossey et al., 1988). It has been commonly believed that gender differences in mathematics learning appear at early adolescence.

At that time, boys usually score higher than do girls on high cognitive level tasks and this difference increases throughout secondary school. Fennema (1988) has stated that the more nearly the measurement instrument includes items of high levels of cognitive complexity that have not been explicitly taught, the more gender differences will be found. The mathematics achievement tests used here included items of increasing complexity and the most complex are not traditionally included in first grade mathematics curriculum.

These first grade teachers had more knowledge about highly successful girls than about highly successful boys and about equal knowledge of low achieving girls and boys. Approximately half of the teachers chose *no* girls as their most successful during either of their free choices. All data for this study were collected near the end of the academic year. Thus, it is impossible to know whether gender differences in achievement were present at the beginning of the year. We cannot conclude that the differences which we found could be partially explained by instructional decisions which were influenced by differential teacher expectations of girls and boys. However, most studies that have investigated differential treatment of boys and girls report that boys appear to receive preferential treatment by teachers (Koehler, 1985; Leinhardt, Seewald, and Engel, 1979). If these teachers had seen gender differences earlier in the year, they might not have attempted to eliminate it because they felt unable to do so. The attribution data from this study support this speculation.

Boys' successes were attributed more to ability than were girls' successes. Many people believe that ability is an inherent, unchangeable capacity to learn. Did these teachers believe that boys just possessed more ability to learn mathematics than did girls and thus nothing they could do would enable the girls to "catch up"? It should also be pointed out that these teachers reported that teacher help or lack of help was more important to their least successful boys' successes and failures than it was to the girls. Teachers' attribution of success and failure in this way usually has been interpreted as an indication of the responsibility that teachers accept for ensuring that their students learn (Guskey, 1982). This could have been another indication that the teachers felt that help would not eliminate the gender differences. On the other hand, girls' successes were attributed predominantly to effort which is partly in the teachers' control. Thus, teachers might have encouraged girls to try harder which would lead the girls to believe that their achievement was due to an unstable cause. It is impossible, without more information, to know why teachers attributed causation of mathematics the way that they did. However, it appears

reasonable to conclude that the attributional style exhibited by these teachers would be more detrimental to girls' achievement behavior than to boys.

The teachers did stereotype girls and boys differently in relation to mathematics. Of the 16 phrases selected from the Broverman scale, only three were seen as differentially describing the best boy and girl mathematics students: competitive, logical, and adventurous. It appears that these traits may be important in the learning and use of mathematics. In addition, there were significant differences on three specific mathematics items that were added to the Adjective Check List. Boys were perceived as volunteering answers to problems more often, enjoying math more, and more independent in math than were girls. Many of these behaviors perceived as different for girls and boys appear to be autonomous learning behaviors which were hypothesized by Fennema and Peterson (1985) as being causal factors in the development of gender differences in mathematics.

Behavior such as volunteering answers, enjoyment, and independence may be influential in continued growth in high cognitive level mathematics learning and these behaviors were reported to be more descriptive of boys. One can only speculate at this point as to what influence these stereotyped beliefs about girls and boys had on teachers' interactions and impact on the learning of mathematics by their students, but it appears clear that these first grade teachers believed that their best boy mathematics students were somewhat different than were their best girl mathematics students in ways important to the learning of mathematics.

In summary, these teachers' attributions and beliefs about first-grade boys and girls in mathematics were different. They perceived boys as being their best students, attributed effort and ability as reasons for successes and failures differently. They believed that the causes of successes and failures were different for boys and girls, and the way in which attributions for girls were made are widely believed to have a negative impact on achievement. Teachers also believed that boys exhibited more autonomous learning behaviors. While characteristics of good boy and girl math students were similar, teachers perceived that boys showed stronger characteristics than did girls.

It appears that teachers' knowledge about gender differences which existed had not eliminated inequities in mathematics. These teachers were aware that girls were not learning mathematics as well as were boys and yet inequity in achievement had not been eliminated. These teachers also held differential beliefs about girls, boys, and mathematics. If teachers' beliefs are important influences on how they interact with and teach their children, then these teachers' beliefs could be seen as an influence on the development of gender differences in mathematics.

Do teacher attributions and beliefs make a difference? Consider the following which was observed in a first-grade classroom.

> The children were renaming the number name of the day's date which happened to be the third of the month. Various children were giving responses appropriate to their ability like $10 - 7$ or $4 \times 3 - 9$. Jesse said $30 - 27$. The teacher, who had not responded to most of the other children's suggestions, appeared somewhat angry. She looked hard at Jesse and said: "That is not good enough!" Jesse appeared somewhat dismayed and literally disappeared from the group. About 10 minutes later, Jesse reappeared and gave the solution $2{,}548 + 1{,}546 + 1{,}234 + 5{,}876 = 11{,}104$. $11{,}104 - 11{,}101 = 3$. (Jesse had actually made a mistake in addition which is irrelevant to this discussion.) The teacher responded to this enthusiastically and the entire class worked with her to check Jesse's work. When the teacher was asked later about her reasons for responding to Jesse in that way, she said that Jesse was a child of high ability who sometimes had to be pushed to work at an appropriate level. In other words, the teacher perceived that Jesse had ability to do mathematics and that her role was to ensure that Jesse exerted effort sufficient to enable high level performance. Because the teacher had attributed Jesse's past successes to ability, and because she had assumed some responsibility for Jesse's effort, Jesse had an extremely positive learning experience in mathematics.

This study raises critical questions about teachers' influence on gender differences in mathematics which need to be investigated. Do differential teacher beliefs cause them to interact with females in such a way that females develop negative feelings about themselves and mathematics? Do teacher beliefs influence girls, less than boys, to develop dependence in mathematics? If gender differences in learning mathematics are to be eliminated, more research which investigates teachers' beliefs and knowledge about girls, boys, and mathematics is essential.

ACKNOWLEDGEMENTS

The research reported in this paper was funded in part by a grant from the National Science Foundation (Grant No. MDR-8550236). The opinions expressed in this paper do not necessarily reflect the position, policy, or endorsement of the National Science Foundation.

REFERENCES

Bar-Tal, D. and Frieze, J. H.: 1977, 'Achievement motivation for males and females as a determinant of attributions for success and failure', *Sex Roles* 3, 301–313.

Bar-Tal, D. and Guttmann, J.: 1981, 'A comparison of teachers', pupils', and parents' attributions regarding pupils' academic achievements', *British Journal of Educational Psychology* 51, 301–311.

Broverman, I. K., Broverman, D., Clarkson, F. E., Rosenkrantz, P. S., and Vogel, S.: 1970, 'Sex-role stereotypes and clinical judgements of mental health', *Journal of Consulting and Clinical Psychology* **34**, 1–7.

Bussis, A. M., Chittenden, F., and Amarel, M.: 1976, *Beyond Surface Curriculum*, Westview Press, Boulder, Colorado.

Carpenter, T. P., Fennema, E., Peterson, P. L., and Carey, D. A.: 1988, 'Teachers' pedagogical content knowledge of students' problem solving in elementary arithmetic', *Journal for Research in Mathematics Education* **19**(5), 385–401.

Clark, C. M. and Peterson, P. L.: 1986, 'Teachers' thought processes', in M. C. Wittrock (ed.), *Third Handbook of Research on Teaching*, pp. 255–296, Macmillan, New York.

Connors, R. D.: 1987, *An Analysis of Teacher Thought Processes, Beliefs, and Principles during Instruction*, Unpublished doctoral dissertation, University of Alberta, Edmonton, Canada.

Cooper, H. M. and Burger, J. M.: 1980, 'How teachers explain students' academic performance: A categorization of free response academic attributions', *American Educational Research Journal* **17**(1), 95–109.

Cooper, H. M.: 1979, 'Pygmalion grows up: A model for teacher expectation communication and performance influence', *Review of Educational Research* **49**, 389–410.

Deaux, K.: 1976, 'Sex: A perspective on the attribution process', in J. Harvey, W. Ickes, and R. Kidd (eds.), *New Directions in Attributional Research*, Vol. 1, Lawrence Erlbaum, Hillsdale, NJ.

Dossey, J. A., Mullis, I. V. S., Lindquist, M. M., and Chambers, D. L.: 1988, *The Mathematics Report Card: Are We Measuring Up?*, Educational Testing Service, Princeton, NJ.

Fennema, E.: 1987, 'Sex-related differences in education: Myths, realities, and interventions', in V. Koehler (ed), *Educator's Handbook: Research into Practice*, Longman.

Fennema, E.: 1990, 'Teachers' beliefs and gender differences in mathematics', in E. Fennema and G. Leder (eds.), *Mathematics and Gender: Teacher and Student Influences*, Teachers College Press, New York.

Fennema, E. and Peterson, P. L.: 1985, 'Autonomous learning behavior: A possible explanation of gender-related differences in mathematics', in L. C. Wilkinson, and C. B. Marrett (eds.), *Gender-Related Differences in Classroom Interactions*, pp. 17–35, Academic Press, Orlando, Florida.

Fennema, E. and Peterson, P. L: 1987, 'Effective teaching for girls and boys: The same or different?', in D. C. Berliner and B. V. Rosenshine (eds.), *Talks to Teachers*, pp. 111–125, Random House, New York.

Frieze, I. H., Whitley, B. E., Hanusa, B. H., and McHugh, M. C.: 1982, 'Assessing the theoretical models for sex differences in causal attributions for success and failure', *Sex Roles* **8**, 333–343.

Graham, S.: 1984, 'Teacher feeling and student thoughts: An attributional approach to affect in the classroom', *The Elementary School Journal* **85**, 91–104.

Guskey, T. R.: 1982, 'Differences in teachers' perceptions of personal control of positive versus negative student learning outcomes', *Contemporary Educational Psychology* **7**, 70–80.

Hallinan, M. T. and Sorensen, A. B.: 1987, 'Ability grouping and sex differences in mathematics achievements', *Sociology of Education* **60**, 63–72.

Hyde, J. S., Fennema, E., and Lamon, S. J.: in press, 'Gender differences in mathematics performance: A meta-analysis', *Psychological Bulletin*.

Janesicki, V.: 1977, *An Ethnographic Study of a Teacher's Classroom Perspective*, Unpublished doctoral dissertation, Michigan State University, East Lansing.

Kaeley, G. S.: 1988, 'Sex differences in the learning of post-secondary mathematics in a neo-literate society', *Educational Studies in Mathematics* **19**, 435–457.

Koehler, M. S.: 1985, *Effective Mathematics Teaching and Sex-Related Differences in Algebra One Classes*, Unpublished doctoral dissertation, University of Wisconsin-Madison.

Leder, G. C.: 1987, 'Teacher-student interaction: A case study', *Educational Studies in Mathematics* **18**, 255–271.

Leinhardt, G., Seewald, A. M., and Engel, M.: 1979, 'Learning what's taught: Sex differences in instruction', *Journal of Educational Psychology* **79**(4), 432–439.

Lorenz, J. H.: 1982, 'On some psychological aspects of mathematics achievement assessment and classroom interaction', *Educational Studies in Mathematics* **13**, 1–20.

Marland, P. W.: 1977, *A Study of Teachers' Interactive Thoughts*, Unpublished doctoral dissertation, University of Alberta, Edmonton, Canada.

Munby, H.: 1983, April, *A Qualitative Study of Teachers' Beliefs and Principles*, Paper presented at the annual meeting of the American Educational Research Association, Montreal, Canada.

Northam, J.: 1988, 'Girls and boys in primary maths books', in L. Burton (ed.), *Girls into Maths Can Go*, pp. 110–116, Holt, Rinehart, & Winston, London.

Peterson, P. L. and Barger, S. A.: 1985, 'Attribution theory and teacher expectancy', in J. B. Dusek, V. C. Hall and W. J. Meyer (eds.), *Teacher Expectancies*, pp. 159–184, Lawrence Erlbaum Associates, New Jersey.

Peterson, P. L., Fennema, E., Carpenter, T. P., and Loef, M.: 1989, 'Teachers' pedagogical content beliefs in mathematics', *Cognition and Instruction* **6**(1), 1–40.

Prawat, R. S., Byers, J. L., and Anderson, A. H.: 1983, 'An attributional analysis of teachers' affective reactions to student success and failure', *American Educational Research Journal* **20**(1), 137–152.

Shuard, H.: 1986, 'The relative attainment of girls and boys in mathematics in the primary years', in L. Burton (ed.), *Girls into Maths Can Go*, pp. 23–37, Holt, Rinehart, & Winston, London.

Skemp, R. R.: 1978, 'Relational understanding and instrumental understanding', *Arithmetic Teacher* **26**, 9–15.

Stage, E. K., Kreinberg, N., Eccles (Parsons), J., and Becker, J. R.: 1985, 'Women in mathematics, science, and engineering', in S. S. Klein (ed.), *Handbook for Achieving Sex Equity Through Education*, Johns Hopkins University Press, Baltimore.

Thompson, A. G.: 1982, *Teachers' Conceptions of Mathematics and Mathematics Teaching: Three Case Studies*, Unpublished doctoral dissertation, University of Georgia, Athens.

Weiner, B.: 1979, 'A theory of motivation for some classroom experiences', *Journal of Educational Psychology* **71**, 3–25.

Weiner, B.: 1974, *Achievement Motivation and Attribution Theory*, General Learning Press, Morristown, NJ.

Wolleat, P. L., Pedro, J. D., Becker, A. D., and Fennema, E.: 1980, 'Sex differences in high school students' causal attributions of performance in mathematics', *Journal for Research in Mathematics Education* **11**(5), 356–366.

Wisconsin Center for Education Research ELIZABETH FENNEMA
Michigan State University PENELOPE L. PETERSON
Wisconsin Center for Education Research THOMAS P. CARPENTER
Illinois State University CHERYL A. LUBINSKI