GENDER DIFFERENCES IN MATHEMATICS ACHIEVEMENT:
AN ANALYSIS OF THE 2003 COMMON ENTRANCE EXAMINATIONS
IN THE COMMONWEALTH OF DOMINICA

A thesis presented to
the faculty of College of Education of
Ohio University

In partial fulfillment
of the requirements for the Degree
Master of Education

Leandra D. Laidlow
August 2004
This thesis entitled

GENDER DIFFERENCES IN MATHEMATICS ACHIEVEMENT: AN ANALYSIS
OF THE 2003 COMMON ENTRANCE EXAMINATIONS IN THE
COMMONWEALTH OF DOMINICA

By
Leandra D. Laidlow

has been approved for
the Department of Educational Studies and
the College of Education by

Gordon Brooks
Assistant Professor of Research and Evaluation

James Heap
Dean, College of Education
LAIDLOW, LEANDRA. M.Ed. August 2004. Educational Studies

GENDER DIFFERENCES IN MATHEMATICS ACHIEVEMENT: AN ANALYSIS OF THE 2003 COMMON ENTRANCE EXAMINATIONS IN THE COMMONWEALTH OF DOMINICA (72 pp.)
Director of Thesis: Gordon Brooks

Four hundred and thirty six students of the Roseau public elementary schools’ mathematics scores on the 2003 Common Entrance Examinations are analyzed to investigate the presence or absence of gender differences. These differences are to be analyzed with reference to geographic location (urban, suburban, rural, and deep rural) and districts (west, east, and south). A 2 x 4 ANOVA is used to investigate gender differences by geographic location and a 2 x 3 is used to investigate differences by districts. Two alternative analyses form part of the study. A one–way ANOVA is used to investigate gender differences in the eastern district comprising of only deep rural schools and a three-way ANOVA is also used to answer the overall questions of gender differences. The results of the two-way and three-way ANOVAS on of the CEE, girls have outperformed their male counterparts. It has also been revealed that there are urban and rural differences as well as western and eastern differences between male and female in mathematics performance. The one way ANOVA did not reveal any gender differences within the eastern district. Generally, it can be concluded that girls have performed better than boys on the mathematics section of the 2003 CEE in Roseau in the Commonwealth of Dominica. Contains 40 references, 10 tables, and 4 figures.

Approved:

Gordon Brooks
Assistant Professor of Research and Evaluation
DEDICATION

This thesis is dedicated to my life long partner, Gloria Lewis who has been
the main source of success in my life. She has spent many years supporting me
while I undertook my academic journeys. I am sorry if I was absent during the
times you needed me most but I know that you understood the cause.

It is also dedicated to my nieces, Wendy and Monique, who continued to
support Gloria when the times were rough and prayed for the Lord to shine the rays of
hope that lead me along the right academic path free of sickness.

I would like to dedicate this work to all my friends, most notably, Dr.
Rosalie Dance and Michelle who encouraged me to continue unrelentingly on this
academic path. Many thanks go out to the Organization of American States and
LASPAU for affording me the scholarship enabling me to pursue this degree.
Finally, I would like to dedicate this work to my deceased Mother, Rosemarie
Maxime. Although you are no longer with us, you would be proud.
ACKNOWLEDGEMENTS

I would like to thank God for granting me good health, a sound mind and the strength to complete this work. Without the grace of God and his willingness to allow me to persevere, this experience would not be possible.

I extend sincerest thanks to my academic advisor Dr. Gordon Brooks for his insightful guidance. I express thanks for his patience with my many questions and affording me the opportunity to question, comment, and learn quite a bit about research and evaluation in a nurturing environment.

Much gratitude goes out to Dr. George Johanson for affording me the opportunity to thrive in an academically nurturing environment. I was very lucky to be so many of his classes and learnt quite a bit. I also thank him for being patient, for offering thoughtful suggestions, and guidance.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>3</td>
</tr>
<tr>
<td>Dedication</td>
<td>4</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>5</td>
</tr>
<tr>
<td>List of Tables</td>
<td>9</td>
</tr>
<tr>
<td>List Figures</td>
<td>10</td>
</tr>
<tr>
<td>Chapter 1</td>
<td>11</td>
</tr>
<tr>
<td>General Introductory Statement</td>
<td>11</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>15</td>
</tr>
<tr>
<td>Gender Differences</td>
<td>17</td>
</tr>
<tr>
<td>Research Questions</td>
<td>18</td>
</tr>
<tr>
<td>Research Hypotheses</td>
<td>18</td>
</tr>
<tr>
<td>Significance of the Study</td>
<td>19</td>
</tr>
<tr>
<td>Delimitations</td>
<td>19</td>
</tr>
<tr>
<td>Limitations</td>
<td>20</td>
</tr>
<tr>
<td>Definitions of Terms</td>
<td>21</td>
</tr>
<tr>
<td>Other Definitions</td>
<td>21</td>
</tr>
<tr>
<td>Organization of the Study</td>
<td>22</td>
</tr>
</tbody>
</table>
Chapter 2……………………………………………………………………………23
  Review of the Literature..............................................................................23
  Piaget’s Cognitive Development.................................................................24
  The Sensori-motor Stage.............................................................................24
  The Pre-operational Stage..........................................................................25
  The Formal-operations Stage.................................................................26
  The Importance of Mathematics Achievement........................................28
Gender Differences in Mathematics Achievement in the United States and
Metropolitan Countries.............................................................................29
Gender Differences in Mathematics Achievement in Urban, Suburban, and Rural
Settings.........................................................................................................31
Gender Differences in Mathematics Achievement in the Caribbean..........34
Chapter 3.......................................................................................................38
  Methodology...............................................................................................38
  Instrumentation..........................................................................................41
  Data Collection............................................................................................42
  Data Analysis...............................................................................................43
Chapter 4.......................................................................................................45
  Results and Implications of the Study........................................................45
  Introduction..................................................................................................45
<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Distribution of Students within Districts and Geographic Location</td>
<td>39</td>
</tr>
<tr>
<td>2. Distribution of Students by Gender and District</td>
<td>40</td>
</tr>
<tr>
<td>3. Distribution of Students by Gender and Location</td>
<td>40</td>
</tr>
<tr>
<td>4. Means and Standard Deviation of Mathematics for Gender</td>
<td>47</td>
</tr>
<tr>
<td>5. Means and Standard Deviation for Mathematics by Geographic Location</td>
<td>49</td>
</tr>
<tr>
<td>6. Means and Standard Deviation of Mathematics by District</td>
<td>51</td>
</tr>
<tr>
<td>7. Analysis of Variance for Gender by Geographic Location</td>
<td>53</td>
</tr>
<tr>
<td>8. Analysis of Variance for Gender by District</td>
<td>55</td>
</tr>
<tr>
<td>9. Means and Standard Deviation of mathematics Scores</td>
<td>57</td>
</tr>
<tr>
<td>10. Analysis of Variance for the Eastern District</td>
<td>58</td>
</tr>
</tbody>
</table>
**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Histogram of Distribution for Raw Mathematics Scores</td>
<td>48</td>
</tr>
<tr>
<td>2. The distribution of the mathematics scores by gender</td>
<td>49</td>
</tr>
<tr>
<td>3. Distribution of students by gender and location</td>
<td>50</td>
</tr>
<tr>
<td>4. Distribution of mathematics scores by gender and district</td>
<td>52</td>
</tr>
</tbody>
</table>
Chapter 1

General Introductory Statement

Examinations still remain a major tool of assessment in our education system. Tests and examinations are still used to assess students’ knowledge and skills in different disciplines or to serve as an indicator of students’ academic achievement or their readiness to move from one level to the next (Oosterhof, 2001). In the Commonwealth of Dominica (Dominica), one of the formal high stakes examinations administered is the Common Entrance Examinations (CEE). The examination serves as an entrance examination to all secondary institutions in Dominica. The CEE is an assessment undertaken by the Ministry of Education in the Commonwealth of Dominica. The examination takes place in every district all over the Dominica and during the month of April. The CEE is the first formal high stakes examination taken by 11-13 year old elementary school students. The exam is of major importance to all students in Dominica and students of the Roseau zone must compete, like all other student, for the limited number of seats available in high schools.

The education system in Dominica is organized into four main levels: pre- primary, primary, secondary and tertiary. Students from three to four years of age attend the pre-primary and those from 5 to 12 attend grades K to 6. All students from grade six sit the CEE. Students who have been successful attend academically oriented secondary schools while those who are not selected or “fail the CEE” attend an alternative track called the Junior Secondary Program (JSP) where they remain for
three years. At the end of the three years, these students sit a qualifying exam acronymed JSP. On acquiring a grade one on the test, they become eligible to follow the traditional secondary track. Students who are unsuccessful on the JSP at age 16 become responsible for their academic life (http://www.unesco.org/wef/countryparts/dominica/rapport).

The Roseau zone is a collection of public secondary schools situated in the capital city. The zone consists of two public secondary schools. These schools are the Dominica Grammar School and the Goodwill Secondary School, both co-educational institutions. Fourteen government elementary schools in the Roseau zone feed into the Roseau secondary zone. The elementary schools include Boetica, Delices, Giraudel, Goodwill, Jones Beupierre, Laudat, Massacre/Canefield, Morne Prosper, Newtown, Roseau Primary, Scotts Head, Soufriere, St. Lukes, and Wotten Waven.

Before a scrutiny of the CEE can be undertaken, it is necessary to examine the history of the CEE in terms of its origin and implementation in the Caribbean. The CEE was instituted in England in the early 1940s. Its purpose at that time was to assess the basic foundational knowledge of primary schools students of grade 6 in the subject areas of Mathematics, English Language, Science, and Social Studies (Mackenzie, 1989). Many countries in the Caribbean use the CEE as the main means of selecting elementary students for entrance into secondary schools. Due to the paucity of materials in Dominica, the researcher will draw on reviews of the CEE from fellow Caribbean countries whose conditions are similar to those prevalent in Dominica.
Before the CEE was instituted, no examination existed which had as its specific purpose the facilitation of transition of students from elementary to secondary school. This was mainly due to the scarcity of secondary institutions in Dominica. Students were accepted into the private church schools based on their performance in standard five, now called grade six (US grade 7 equivalence). The construction of a few government secondary institutions influenced the need for an entrance examination.

The idea for the examinations was borrowed from England and the examination was introduced in the island in the early 1960’s. In 2003, 1,544 students all over the island of Dominica vied for the fewer than 600 seats at the secondary institutions all over Dominica. This competition causes much agony for students, parents and guardians, and often results in the marginalization of those students who are unable to gain access to the secondary institutions because they “fail” the examination.

The Trinidad Guardian’s 2003 article, ‘How School System Destroy Children’ alluded to the fact that in Trinidad and Tobago, the school system was systematically destroying the psyche of students not selected for entrance to secondary school. The newspaper article reiterates various drawbacks of the Common Entrance Examination system, some of which are the anxiety, depression, pains, fever, delirious behavior and severe panic attacks it brought unto the students. The article reiterates the fact that the problem began with the process of making choices among schools prior to the publication of the results of Common Entrance Examination. It added that before the
child wrote the examination he/she, with the assistance of parents or guardians, had to select by priority the school that they wished to attend. This was the beginning of the psychological catastrophe. The child is considered a dunce if he passes for a non-traditional secondary school or a school that is not considered a prestigious school, according to the article. Upon failing to be selected, students often convince themselves that if they were bright they would not have been placed in “that” secondary school, referring to the government secondary school. When the child's confidence is destroyed, at such a tender age, it is almost impossible for that child to develop into the scholar that she/he is capable of being. Presently, a few of the public secondary schools in Dominica have grown in popularity; however, the Trinidad scenario is similar to what occurred and is still occurring in Dominica. From my 22 years of experience in education in Dominica, I have witnessed the devastation caused to students when they fail the CEE.

Mackenzie (1989) supports the Trinidad Guardians’ article claim by identifying some adverse effects of the CEE. The author contends that the CEE distorts a good primary education, reduces primary school system into a viciously competitive rat-race, and fosters a variety of illnesses and disabilities among children including paralysis, hysteria, stress, drug addiction, and even blindness.

On the flip side, there are indeed some positive consequences to high stakes testing. According to Cizek (2001), high stakes tests (like the CEE) allow for professional development as it assists educators in increasing the content knowledge of their disciplines. High stakes testing also makes teachers more reflective,
deliberate and critical in terms of their own classroom instruction and assessment with the goal of success for all students.

The CEE became an integral part of the education system and in 2003, the CEE tested elementary school students in four subject areas: mathematics, language arts (with a composition component), science, and social studies. The mathematics test items were classified into topic areas and the 60 multiple-choice items addressed different aspects of the mathematics requirements of the students of that age cohort. There were a fair amount of straightforward questions that tested knowledge, however, some questions allowed for comprehension and application of mathematical concepts. One encouraging aspect of the mathematics section was the inclusion of problem solving that involved the use of a combination of procedural knowledge in solving mathematical situations in real world settings.

Statement of the Problem

The secondary school system in Roseau, Dominica, is about to undergo a significant transformation. According to a press release on The Dominica Broadcasting Corporation on April 18th, 2004, the Prime Minister of Dominica, Roosevelt Skerrit announced that a new secondary school will be built in the Roseau zone for the 2005 school year. Additionally, as the eve of Universal Secondary Education (USE) draws near more seats will soon be available to elementary school students since every primary school student will be forwarded unto high school. In 2003, a total of 121 out of 436 students, 90 males and 31 females were not selected to attend secondary schools based on their performance on the CEE. According to an article in the
Government Press Services, on Monday, July 14th 2003, Claudia Monlouis reiterated in article *Boys Capture Top Ten Common Entrance Places* that although males have taken the top ten places at this years’ CEE, the trend in recent years shows a decline in the number of successful males gaining access to secondary schools, a cause for concern for educators and parents: (http://www.stlucia.gov.lc/pr2003/boys_capture_top_common_entrance_places.htm).

This research is significant as it provides information on the differential performance of boys and girls on CEE mathematics test in the Commonwealth of Dominica. Additionally, as more secondary seats become available, it begs the question of the readiness of future students for such a major educational undertaking. This study seeks to ascertain whether differences exist in mathematics achievement of students in the public elementary schools as it relates to sex, school, school location, and districts. If differences do exist, then the government, and in particular the Ministry of Education, must ensure that the practices of the elementary schools be examined and upgraded to provide effective instruction in the area of mathematics before the institution of USE in the Roseau zone. Improving the quality of primary school education and raising the level of numeracy among primary school students, in particular males will better prepare students for the CEE and maximize their capacity to make use of the opportunities to be provided at the secondary level when USE is implemented in the Roseau zone. According to the Dakar Framework and Millennium Development Goals (MDGs), by 2005, the existing gender disparities in primary and
secondary schooling are to be eliminated and that equality through out education achieved within this century (UNESCO, 2001).

*Gender Differences*

In the 2003 CEE examinations, the ratio of boys to girls who were not successful in the examinations was three to one; there were 90 males and 31 females. On the eve of USE in the Roseau zone, it is imperative that prospective male high school students’ mathematics achievement be enhanced through the careful planning and implementation of effective mathematics educational programs at the primary level. USE is a comprehensive package of measures geared at ensuring equitable access to quality secondary education. Kutnick, Jules and Layne (1997) have explored why females achieve comparatively better educational achievement scores in the CEE in the Caribbean and their original research show widespread success of girls in the CEE. Their research concluded that females outperform and outnumber males at various levels of schooling in a broad range of curriculum subjects (mathematics included) and this is substantiated on within class and national examinations such as the CEE. *The Caribbean Education Strategy* produced by the World Bank clearly articulates that in terms of gender equity, both boys and girls have equal access, but there is growing disparity in participation rates between boys and girls at the secondary and tertiary levels. Fewer boys gain a place at secondary level where there is competition for places. They perform less well and there is a higher attrition rate than girls. As a consequence, girls at the tertiary levels outnumber them. The ratio at the University of the West Indies (UWI) is 67: 33 in favor of
females. Recent studies on gender emphasize the need for measures to be taken to promote the motivation of boys and higher levels of performance.

*Research Questions*

The purpose of the study is to identify gender differences in mathematics achievement among urban, suburban, rural, and deep rural public elementary schools students within the Roseau zone and within districts of the zone. The following research questions are proposed.

1. Do male and female public elementary schools student in the Roseau zone differ significantly in mathematics achievement?
2. Are there significant differences in mathematics achievement among urban, suburban, rural, and deep rural male and female students in public elementary schools?
3. Does the mathematics achievement of male and female elementary school differ significantly within districts (southern, eastern and western) of the Roseau zone?

*Research Hypotheses*

1. Males and female public elementary students are significantly different in mathematics achievement.
2. Urban and suburban school students perform significantly different to rural and deep rural students.
3. There are significant differences in mathematics achievement at the district
level among male and female public elementary school students of the Roseau zone.

Significance of the Study

The purpose of the study is to identify differences in mathematics achievement among urban, suburban, rural, and deep rural public elementary schools within the Roseau zone and within districts of the zone. The study also seeks to ascertain whether differences exist within the public elementary schools and among male and female students. The study will explore and assess gender differences in mathematics achievement on the 2003 CEE in an attempt to lay the groundwork for future research on testing in the Commonwealth of Dominica. The study will highlight the need for continual research on the CEE in respect to its validity and predictability. There will also be the need to perform item analyses or investigate the subscales where the gender disparities are the greatest in an effort to reduce the gender gap. The results of the study will encourage policy makers to extend the limit of the age should be allowed to sit the CEE.

Delimitations

Data from the CEE results for 2003 for the Roseau zone were used in this study. The 2003 results were used because the government has declared that a new secondary school for the Roseau zone will be built in the next school year, thus creating the need for national analysis of past performances of students. With more high school seats being created and made available, and as universal education slowly becomes a reality, the need arises to examine the selection processes in the Roseau
zone. If differences are shown to exist, then better educational opportunities should be made available to those who would not have been selected in previous years. Since only the public school students in the Roseau zone are used in this study, it is also important to understand that the results of the study may not generalize to students of the private schools of the Roseau district and should not reflect all other results, past or future. The study was limited to male and female students of the public elementary schools that feed unto the Roseau zone and the results of the study may not generalize beyond the Roseau zone.

Limitations

The use of pre-existing data (results of the mathematics achievement score on the 2003 CEE) limits the analyses to the variables collected and present in the data; therefore, the results of the study cannot be used to make any causal statements. There was no access to item level data and this precluded the researcher from performing much useful and important analyses of the mathematics achievement on the CEE. It also makes formulating an operational definition of mathematics achievement very difficult. This is so because the term mathematics achievement refers to a complex set of skills and competencies rather than to a static, easily labeled phenomenon. Additionally, it is possible neither to interpret the scores in relation to other norms nor to determine how students in any one year would rank in comparison with students in other years. A plethora of literature indicates that the factors that contribute to mathematics achievement are complex; therefore, other variables of interest should be taken into consideration when discussing the results.
**Definition of Terms**

**Dependent variable.** Mathematics achievement is measured as a raw total score that represents the students’ credit with set of specific skills after completing the mathematics section of the Common Entrance Examinations.

**Independent variables.** Geographic location is subdivided into the following categories: (a) Urban Schools: school within walking distance (located less than half mile) from the Roseau zone, (b) Suburban Schools: schools within one to five miles from the Roseau zone, (c) Rural Schools: schools within six to ten miles inclusive from the Roseau zone, (d) Deep Rural Schools: schools located ten and more miles from Roseau zone. District refers to a collection of schools located in the north, south, west, and east of Dominica that feeds unto the Roseau zone. Gender is defined according to biological characteristics, subdivided into (a) male and (b) female.

**Other Definitions**

**Common Entrance Examinations** (CEE). The CEE is an achievement test designed by the Ministry of Education in the Commonwealth of Dominica and used to select elementary (grade six) students for entrance into high school. The components of the CEE are mathematics, science, social studies, and language arts.

**Roseau zone.** The Roseau zone refers to a set of secondary schools located around the capital city that provide placement for elementary school students who are selected to attend secondary school.
Public elementary school. Public elementary schools are school for which the government is responsible and whose overall functioning and financing it oversees.

Organization of the Study

The preceding chapter one comprises a general introductory statement regarding the CEE. The central problem seeks to find differences in mathematics achievement among male and female elementary school students in terms of school location and district. In addition, the chapter provided information on the specific research questions to be answered and the hypotheses to be tested. The purpose and significance of the study are stated and its delimitations and limitations explored. Finally, each term relevant to the study is defined. Chapter two presents the review of the literature and presents the theoretical foundation relevant to aspects of Piaget’s cognitive development and addresses issues dealing with school location and gender differential in math achievement. Chapter three explains the methodology, which is broken down into sampling, instrumentation, data collection procedure, and the analysis of the data. Chapter four presents the results, conclusions, and a discussion of the implications of the study. It constitutes the presentation of the findings, conclusions, discussions of these findings, and recommendations for future research and educational practices in the Commonwealth of Dominica.
Chapter 2

Review of the Literature

This study seeks to investigate whether differences exist in mathematics achievement between male and female elementary school students of the Roseau zone. These differences will be investigated with additional references to geographic location and district.

A large body of research exists today reflecting the diverse and complex nature of factors associated with mathematics achievement. These factors range from cognitive processes to social and environmental factors that affect students worldwide. As early as the 1970s gender has emerged as a factor on which students’ performance varies and remains a topic worthy of investigation.

The literature review will highlight Piaget’s theory of cognitive development with special focus on the formal operations period (approximately age 11 or 12 onward). This period is particularly relevant to the study since the students sitting the CEE are supposed to exhibit signs of this cognitive developmental stage. According to Piaget, it is at this stage that all cognitive structures reach maturity, and the child is endowed with the potential of “adult” thought (Wadsworth, 1984). Another focus of the literature review will be the major agreements and disagreements in the existing literature in relation to gender differences in mathematics achievement within the more developed and developing countries. Additionally, the issues surrounding urban-rural mathematics achievement will be discussed.
Piaget’s Cognitive Development

Jean Piaget was born in Neuchatel, Switzerland in 1896. His interests ranged from biology to epistemology, logic and developmental psychology. He was fascinated with problems of cognitive development that led him to focus on that central area during the rest of his career. He observed children’s patterns of errors and developed an explanation of his theory of cognitive development. He can be considered a pioneer in cognitive theories.

Piaget’s cognitive developmental theory is primarily concerned with describing and explaining in a very systematic way the growth and development of intellectual structures and knowledge (Wadsworth, 1984). Piaget’s cognitive development theory describes four stages of cognitive development: the sensori-motor, the pre-operational, concrete operations, and formal operations. The fourth stage is particularly relevant to this study as it asserts that adolescents’ cognitive structures have reached maturity and they are able to function like adults and perform many complex mathematical operations.

The Sensori-Motor Stage

At this stage, between zero and two years, an infant crosses the many boundaries of actual attainment of the conceptual understanding. At birth, a child’s behavior is reflexive. Toward the second month, the infant makes primitive differentiations of objects in the immediate environment through sucking reflex. By the end of the fourth and eight month, the development of vision and touch occurs. By the first year, the child develops object permanence and awareness that objects
other than himself or herself can cause events. During the second year, true intelligence behavior typically evolves; the child constructs new means to solve problems through experimentation. By the end of the second year, the child becomes able to internally represent objects and events. This ability liberates the child from sensori-motor intelligence, permitting the invention of new methods to solve problems (Copeland, 1997).

The Pre-operational Stage

This stage begins between ages two to seven. At this stage, children acquire language rapidly, mainly between the ages of two to four. Children are very egocentric and nonsocial. They do not possess the ability to reverse operations and perceptions tend to be centered. This severely inhibits fast, abstract and unrestricted thought. Representation and language development facilitates the beginning of true social behavior. They begin to show signs of moral feelings and reasoning. They reason about rules and justice however they lack autonomy. The period of preoperational intelligence may be characterized as the stage of symbolism or representation where the child begins to manipulate symbols or representations of the physical world where they live. The stage of concrete operations

At this point, between the ages of seven and eleven, reasoning becomes logical. Logical operations have been developed through normal maturation. These operations can be applied to concrete situations, solve problems that exist or have existed in their own experience. Seriation and classification, the basis of numbers concepts are developed, as well as autonomy of reasoning. Growth can be seen in
children’s moral concept, such as their understanding of rules, lying, accidents, and justice. They have overcome the concept of conservation during this stage. Children at this stage are aware of the physicality of objects. They are aware that objects occupy space, can be built, counted, and they manifest signs of representing objects using paint and comparison. They are slightly aware of one-dimensionality and are unable to understand volume (Anghileri, 1995).

The Formal-operations Stage

Children at this stage of development, during the ages of 11 or 12 and onward, develop the reasoning and logic to solve all classes of problems. All cognitive structures reach maturity, and the child is endowed with the potential of “adult” thought. A few structures are developed during this period; they are the hypothetical and deductive reasoning, and scientific-inductive thought. Two major cognitive contents develop during formal operations: prepositional, or combinatorial, and formal operations. The formal operational scheme allows the child to reason morally.

Baskovish (2004) states that children at 11 can perform classifications, grouping and substitution, but are unable to effectively compute area and volume. Verbal problems are difficult and children cannot see general laws or properly express functions. However, at about 14 years the child can make systematic analyses, make generalizations, and understand laws, rules and the concept of infinity. Understanding of relations and one to one correspondence also comes to
the fore. However, concepts like volume (three-dimensionality) continue to be problematic (http://www.math.ufl.edu_dept_news_evens/long/essay/baskovish.html). As Wadsworth (1984) states, these developments are characteristic of all normal people. The developments are brought on, not by puberty, but by normal and necessary intellectual and affective developments that take place during the acquisition of formal operations.

Piaget’s formal operational stage relates to the cognitive and affective growth of adolescents and presents clear ramifications for educational practices and for understanding children. Some of these are the ways students construct knowledge; students’ individual differences especially maturation, experiences, social interaction, and motivation. These factors have pronounced effects on achievement and these differences are no different in respect to mathematics achievement.

In respect of the CEE, students are selected between 11 and 13 years to sit the examinations. Miller (1992) questions the age selection of students to sit the CEE. Could the age be extended to 16? What is so magical about the 11 to 13 year old age group when acclaimed theoreticians could not put an actual boundary on when these cognitive developmental aspects of students are most prevalent? A second issue that could be raised and which connects with Piagetian/neo--Piagetian theory relates to the existence or non-existence of a wide gender differential in mathematics performance. If the principles of Piaget’s theory are applied to discussions of the CEE, there should be no cognitive differences between the boys and girls who sit the examination and thus, no significant gender differential should be evident in the CEE results. Copeland
(1997) emphasizes the fact that students at this stage can reason or hypothesize with symbols or ideas, and can use the hypothetic-deductive reasoning procedure. This procedure allows for the consideration of powerful mathematical ideas of proportion, scales, time and distance problems, geometry, and probability.

The Importance of Mathematics Achievement

One of the subject areas tested by the CEE is mathematics. Hashaway (1981) has shown that mathematics is one of the most important school subjects and indicates the need for students to be proficient in the subject area especially during sixth grade or at the formal operations period. It is also important to highlight the pivotal role that mathematics achievement plays in subsequent schooling, career choices and professional development. John Glenn, Commission Chair of the National Commission on Mathematics and Science Teaching for the 21st Century (NCMST), as cited by Patterson, Perry, Decker, Eckert, Klaus, Wending, and Papanastasiou (2003) reiterated that it is extremely important for children to attain competencies in the area of mathematics. The writers cite four main reasons for Glenns’ assertion. These are the constant change in the global economy and the workplace; daily use of mathematics for every day decision-making; the link between mathematics and other subjects; and the intrinsic value of mathematical knowledge in every culture.

Howie, March, Allummoottil, Glencross, Deliwe, and Hughes (2003) further reiterate the importance of increasing mathematical competencies. The authors indicate that the nub of the educational issue is the fact that mathematics is one of
the two principal modes of engaging the world intellectually: words and numbers. The greatest intellectual power, one might argue, as indicated by Miller (1992) entails the faculty of combining words and numbers. Clearly if citizens cannot claim or be given the opportunity to gain intellectual power necessary to sustain democracy, then democratic institutions will founder.

Reasons for the importance of mathematics have universal applications. These are applicable to the Caribbean region and more so the Commonwealth of Dominica, a developing country. Miller (1992) elaborates on the universal set, education, of which mathematics education is a subset by pointing out that education is a dynamic instrument that Caribbean people must use to make the future they desire happen. Thus, mathematics education must not follow trends, nor be influenced by economic, social, cultural, political, and technological realities; however it requires deliberate, conscious, sustained application in pursuit of the intended outcomes of mathematical power for all.

*Gender Differences in Mathematics Achievement in the United States and Metropolitan Countries*

Extensive research has been conducted in the United States and other metropolitan countries on gender differences in mathematics among 11 to 13 year olds (middle school). Much of this research has generally found that male students are slightly superior in math achievement. In fact, these studies have shown a consistent gender difference favoring male students. The results of the meta-
analysis demonstrate a general trend toward male superiority in math achievement (Baker & Jones, 1993; Brandon, Newton, & Hammond, 1985; Hasway, 1981).

The literature can be grouped under the following categories: studies focusing on cognitive, affective, and social variables related to gender difference; studies based on non-representative samples; those based on reasonably representative samples; and meta-analytic studies (Xitao & Chen, 1988).

The studies, grouped into cognitive and affective factors, distinguish male and female differences in mathematics achievement based on problem solving strategies, math anxiety, spatial visualization, and attribution of success to ability, attrition rate from mathematics education, and self rated mathematics education (Peterson & Fennema, 1985). Together these studies present various other factors that can be investigated in the future in Dominica.

Patterson et al. (2003) built a conceptual framework surrounding student gender, student attitude to mathematics, student perception of parental opinions, and student assessment of study time. According to the authors, a large body of evidence suggests that students’ attitude to mathematics is gender related, and that these differences in turn can have the potential to affect mathematics performance. The significant results of the study are that it points to the fact that males tend to have higher mean scores on math content and math attitude.

Berndt, Miller and Kristelle (1990) in a study investigating the relationship between mathematics achievement, expectancies of success, and value students attach to success showed that students’ achievement is more strongly related to their
expectancies of success than to the value they attach to success. Another result from the study is that students’ expectancies and values are positively related. Given the fact that research shows that parents have differential expectations of success for females than males, these differential expectations of achievement will directly affect their math achievement by influencing their own expectations for success and devalue the need for success.

Studies concerning environmental factors seem to be conflicting in the attempt to describe superiority in male achievement. Research has shown that environmental factors impact the achievement of both sexes. Environmental factors are listed as parental involvement and educational levels, expectations of the teacher, amount of study time outside of class, low attendance rates in rural areas, school culture, gender ratio of teacher to students, curriculum and pedagogy, and pupils’ subculture (Howie, Marsh, Allummoottil, Glencross, Deliwe, & Hughes, 2000). The complexities and interplay of these factors continually impinge on the achievement of boys and girls.

Gender Differences in Mathematics Achievement in the Urban, Suburban, and Rural Settings

It has been shown that students from schools of small rural communities may receive an education that is inferior to that received by students from large urban and suburban communities and, consequently, rural-urban differences may exist in terms of students’ academic achievement (Howley, 2002). Additionally, mathematics continues to a subject area in which students need to attain higher
levels of competencies, hence, the issue of urban-suburban-rural differences in mathematical outcomes has been a topic of debate for educational researchers.

Research comparing urban, suburban, rural school students in the area of mathematics in the Caribbean is sparse. Logie (1991) claims that there are fundamental weaknesses in existing educational research in the Caribbean. The sparse research in related cultures is reviewed below. In Dominica, research on mathematics achievement is non-existent.

However, urban-rural mathematics research in the developed countries has yielded inconsistent results. Xitao and Chen (1998), in a meta-analytic study of US rural–urban differences in mathematics achievement, indicates that some studies failed to find any statistically significant differences between rural school students and their counterparts in urban and suburban areas, while others have found that students in urban-suburban areas had better performances than rural students (Young, 1998). One of the studies, conducted by Lindberg (1985), found that US students from small rural schools performed at levels lower than those attending larger urban and suburban schools. Durbrow, Schaefer, and Jimerson (2002) suggest that children from the rural St. Vincent areas are more likely to fail the common entrance examinations than are urban children. The latter study can be associated with the situation that exists in Dominica.

Many factors have and are still contributing to rural/urban/suburban differences in academic achievement, and more so mathematics. Of the many factors impacting mathematics achievement, a few have been identified by various
studies and will be explored here. Several studies have identified factors such as availability of resources, socioeconomic factors, parental expectations, educational level of parents, and community influence as crucial to mathematics achievement.

Alspaugh and Harting (1995) concluded through their study of rural and urban students’ differences in math achievement that: (a) rural students usually have lower socioeconomic status (SES) and this has an impact on achievement and (b) a large proportion of the between school variance in school achievement among urban schools is associated with the students’ SES, while a smaller proportion of the between school variance in achievement among rural schools was associated with students’ SES. Ramos and Sanchez (1995), in a separate study, confirmed the findings of Alspaugh and Harting and revealed that community and parental involvement have generally been considered as positively related to students’ achievement. Hence rural students may be at some disadvantage compared to their urban-suburban counterparts due to the size and location of the community and the low SES of the majority of its residence. Another reason highlighted was that rural communities often enjoy less community involvement in education than do urban communities.

DeYoung and Lawrence (1995) in a study believe that parents in small rural communities often have lower expectations about their children’s educational attainment, and subsequently, the students have lower achievement levels in mathematics. Additionally, Durbrow et al. (2002) noted that the level of maternal and caregiver’s education were different across the two groups (urban/rural)
examined, with the more educated adults associated with those students passing the CEE. They claim that parental education can predict success or affect a child’s school performance. Parental education can facilitate success in their weekly routine, structure use of time outside of school, encourage positive homework practices and facilitate the child’s education.

*Gender Differences in Mathematics Achievement in the Caribbean*

The research surrounding mathematics achievement in industrialized and developed countries sharply contrasts to that which occurs in the Caribbean and other developing countries. The results of research findings from the two regions concerning rural/urban mathematics achievement are comparable with the results of the sparse research found in the Caribbean in mathematics achievement. In both arenas, small rural school students were found to perform at lower levels in mathematics than their urban–suburban counterparts (Logie, 1991; Xitao & Chen, 1998; Young, 1998; Durbrow et al.; Howley, 2002).

For the most part, however, the two strands of research have reported contrasting findings. Peter, Jules, and Layne (1997) report that Caribbean educational research provides a contrasting picture of gender and school achievement from that which is presented by African, Asian, and American researchers. One research finding characteristic of educational outcomes in developing countries is that females show higher reading achievement and higher scores on English and mathematics. It has also been shown that girls score higher than boys in mathematics on the CEE (Parry, 2000). Other research shows similar
results. Brandon, Newton, and Ormond (1995) report that girls have higher mathematics achievement levels than boys. These studies become relevant to this particular study, as gender differences in mathematics achievement will be explored in the 2003 CEE in the Commonwealth of Dominica.

In the Caribbean, the trend observed in research of mathematics achievement is that females largely outperform their male counterparts (Parry, 2000). Official statistics show that females do better than males at both primary and secondary levels of schooling (World Bank, 1993). The report of the World Bank further reiterates the point that gender differences in performance are most noticeable at the first level of testing, the CEE, where females achieve a higher proportion of high school places even where assessment policies have attempted to redress the gender imbalance by discriminating in favor of males. In any case, this is not an educationally sound strategy for addressing gender differentials.

Historically, as far back as 1899, the percentage of male enrollment in secondary institutions in the Caribbean was considerably higher than females (Miller, 1984). This disparity is historically situated and reflects restricted educational opportunities for females compared to males as well as social attitudes that encompassed the notion that education was inappropriate for women (Parry, 2000). Where education was felt to be appropriate for females, it was highly selective and females were channeled into areas that were thought to be necessary for their domestic and child rearing propensities.
Subsequently, the education arena in the Caribbean was liberalized and both sexes now competed equally for placement in high schools and the CEE was adopted. Despite these trends however, it is still evident from the frequencies of the CEE data that males form the greater part of the sample. There were 262 males compared to 174 females. This does not mean that males are favored more than females in Dominica. Of the 262 males and the 174 females to sit the CEE, 172 males and 143 females of the government elementary schools were successful in securing seats at the high school in the Roseau zone. This indicates that 90 males and 31 females were unable to make a successful bid for high school entrance. The ramifications are that the students will be able to retake the examinations only if they are less than 13 years old at the time of the next examinations date or they are sent to a Junior Secondary Program (JSP).

The irony of the JSP is that the same students who were unsuccessful at the CEE are given instruction equivalent to that of the first forms in the traditional (academically oriented) high school. After three years, these students are tested again using the JSP examinations. Successful students are awarded grade ones and this secures them seats at the traditional secondary schools at age 16.

While large-scale surveys and quantitative studies in the Caribbean have traditionally been pervasive, classroom observational research and action research has been virtually ignored (Miller, 1990). Durbrow et al (2002), alluding to this fact state that there is little research on the secondary school entrance examination, the CEE. The authors state that the most extensive reports that they could find were
reports by Mackenzie (1989) and Kutnick et al (1997). The two reports and most recently, Parry (2000), reported that girls usually scored higher on the CEE as well as on other within class achievement measures. Parry also asserts that the CEE is being used as a means of rationing the scarce resource that secondary school positions constitute.

The clear contradiction of the findings on gender differences in mathematics achievement between research done in the United States and industrialized nations and those done in the Caribbean generates a need for additional research on the moderating or extraneous variables that affect the performance of Caribbean males on the Common Entrance Examinations. While conducting additional research in a bid to increase achievement, the Caribbean will experience human resource growth. The consequence of human resource growth is economic growth. The growth patterns can be realized when the citizens irrespective to differences in gender or geographic location are given the opportunities of equal educational experiences.
Chapter 3

Methodology

The purpose of this study was to investigate the differences in mathematics achievement between male and female students enrolled in the public elementary schools of the Roseau zone in reference to location (urban/suburban/rural) and district (west/east/south). The achievement measure was the raw score of each student who sat the CEE.

This chapter describes the following: (1) research questions, (2) student distribution within geographic location and district by sex, (3) instrumentation, (4) data collection procedure, and (5) the various data analysis tools to be used.

The research questions are:

1. Do male and female students differ significantly in mathematics achievement?

2. Are there significant differences in mathematics achievement among male and female elementary school students in the urban, suburban, rural, and deep rural primary schools?

3. Does mathematics achievement among male and female students differ significantly at the district level (south, west, and east) in the Roseau zone?
Table 1

Distribution of Students within Districts and Geographic Location

<table>
<thead>
<tr>
<th>Location</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Urban</td>
<td>0</td>
</tr>
<tr>
<td>Suburban</td>
<td>89</td>
</tr>
<tr>
<td>Rural</td>
<td>57</td>
</tr>
</tbody>
</table>

Table 1 shows the distribution of students by district and location. In the southern district there are 57 rural and 89 suburban students. In the western district there are 160 urban and 73 suburban elementary school students. There are four districts that feed unto the Roseau zone. They are the northern, southern, western and eastern districts. Of the 436 students who sat the CEE in the Roseau zone, there are 243, 146, and 47 students in the western, southern, and eastern districts respectively. There are no public elementary schools located in the northern district that feed unto the Roseau zone, hence the absence of this information. The eastern district will not be part of the fourth research question because the public elementary schools in this location are all deep rural.
Table 2

*Distribution of Students by Gender and District*

<table>
<thead>
<tr>
<th>Gender</th>
<th>District</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South</td>
<td>West</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>87</td>
<td>152</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>59</td>
<td>91</td>
<td></td>
</tr>
</tbody>
</table>

Table 3

*Distribution of Students by Gender and Location*

<table>
<thead>
<tr>
<th>Geographic Location</th>
<th>Urban</th>
<th>Suburban</th>
<th>Rural</th>
<th>Deep- Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>105</td>
<td>85</td>
<td>49</td>
<td>23</td>
</tr>
<tr>
<td>Female</td>
<td>65</td>
<td>48</td>
<td>37</td>
<td>24</td>
</tr>
</tbody>
</table>

A total of 1,544 students sat the Common Entrance Examinations in Dominica in 2003. The students are divided into four districts in respect to the island. Of the
1,544 students, 717 or 46.4% came from the Roseau zone. Four hundred and thirty-six students or 60.8% attend public elementary school. Of the 436 students, 262 are male and 174 are female, representing 60.1 and 39.9 percents respectively of the sample. These 436 students represent the convenience sample taken from the total of six public secondary feeder zones in Dominica (population). These public secondary feeder zones are Grandbay, Roseau, St Joseph, Castle Bruce, Portsmouth, and Roseau is one of the zones. There are three public elementary districts that comprise the Roseau zone. These districts comprises of a total of 14 public elementary schools whose students provided the data to be analyzed in this study. The eight rural/deep rural schools examined in this study had a total of 104 eligible students, while the urban/suburban cohort consisted of 332 students. There were eight rural/deep rural schools, while there were six urban/suburban schools. Each rural/deep rural school averaged about 13 students compared to 55 for each urban/suburban school.

**Instrumentation**

The data were retrieved from the results of Dominica’s 2003 Common Entrance Examinations held annually in the month of April. The CEE has been used in Dominica for the past 50 years as a selective examination for high school entry. Based on the cumulative scores in the four subject areas, students are awarded places at secondary schools. Students receiving a total score of 365 points on the four sections of the CEE and above were awarded scholarships (books, payment of Caribbean Examinations Council exam fees, and monthly stipends) and those with scores between 348 and 364 points inclusive are awarded bursaries (books and
payment of Caribbean Examinations Council exam fees). The published scores of the CEE are all standardized scores, a mean of 100 and standard deviation of 25. The examination of 2003 has a Cronbach’s reliability of 0.92 ($\alpha = 0.92$) Ministry of Education (2003).

The examination is made up of four components: mathematics, science, social studies, and language arts. The questions for each discipline are all objective, except for a written section on the language arts test. The mathematics section of the examination consists of 60 multiple-choice questions covering number concepts, computation, measurement, geometry, decimals and fractions, problem solving, and statistics. The breakdown of the questions of the mathematics test is as follows: 7 questions on number concepts, 15 on computation, 16 on measurement, 6 on geometry, 6 questions on decimals and fractions, 6 problem solving situations and 3 statistical questions (Commonwealth of Dominica, Ministry of Education (2003) Common Entrance Examinations. Roseau, Dominica). The questions were of differing cognitive domains ranging from knowledge to application.

Data Collection

The data was retrieved from the Measurement and Testing Department of the Ministry of Education in the Commonwealth of Dominica. The scores for the mathematics section of the CEE were already accumulated on a diskette. Thus, a copy of the relevant information was available on a diskette for purposes of the study. The data comprised of the raw scores for all students in Dominica who sat the Common Entrance Examinations in April of 2003. From this relevant data, that is, scores of
students of the Roseau public elementary schools for the mathematics section of the examinations was extracted. Permission was given to the researcher to retrieve and use the data by the Minister of Education in the Commonwealth of Dominica by letter. (see Appendix A)

Data Analysis

The sample comprises of public elementary school students of the Roseau zone analyses who had done the CEE in April of 2003. The data will be analyzed using SPSS 11.5 statistical computer software. To allow for future duplication of the study by interested parties in Dominica, the 2 x 3 and 2 x 4 ANOVA are used. A 2 × 4 Factorial Analysis of Variance (ANOVA) will be the most appropriate statistical analyses to investigate mean mathematics achievement differences across gender (male and female) and location (urban, suburban, rural, and deep rural). A 2 x 3 Factorial Analysis of Variance (ANOVA) will be used for the analysis of gender and districts (western, eastern, and southern). However, a 3-way ANOVA can be used to collectively answer all the research questions in relation to gender, geographic location, and district.

In terms of presentation of the findings, descriptive statistics will be displayed in graphs and the normality of distribution of the scores on the dependent variable will be verified using histograms, Q-Q Plots, and the Kolomogrov-Smirnov (K.S) normality test. The ANOVA procedure is relatively robust to the violations on normality (Stevens, 1999). Consequently, deviations from normality in this study will not affect the results of findings. Box plots and the standardized scores will be used to
identify outliers or influential points. The test of assumptions of homogeneity of variances of the dependent variable will be investigated. As the CEE was individually administered, one can assume that the observations, the mathematics scores are independent of each other.
Chapter 4

Results and Implications of the Study

Introduction

The study seeks to investigate gender differences in mathematics achievement among elementary school students as it relates to geographic location and district. The study is exploratory in nature and seeks to provide school practitioners with information related to the existence or non-existence of gender differences in mathematics achievement in Dominica. Since the implementation of USE is inevitable, it is important that mathematics research be implemented and nurtured in an effort to empower teachers and students.

The findings of the formal study will be presented in respect to each research question. After the findings are presented, they will be discussed in reference to the finding of research done in the US, in other industrialized countries, and in the Caribbean. The district analysis will be appropriate only for schools located in the Roseau zone in Dominica.

Finally, the conclusion and recommendations for future research will be presented in order to delve a little further into the factors influencing gender differences in mathematics achievement as it relates to the Commonwealth of Dominica and more so the Eastern Caribbean.

In this chapter, the results will include descriptive statistics of mathematics achievement by gender, geographic location, and district. These descriptives will be presented using tables, box plots, and histograms. The tables will provide information
on the mean and standard deviation of mathematics achievement for each independent variable. The Kolmogorov-Smirnov (KS) will be used to assess the normality of the dependent variable. The inferential statistics results will be provided using tables after completion of the ANOVA tests. One 2 x 4 and 2 x 3 ANOVA will be used to analyze mathematics achievement by geographic location and district. The preset level of significance for each research question is 0.05 and power of 0.80. For the first research question, a small effect size of 0.25 requires a total of 45 subjects per group. For the second research question for the same effect size and power, only 52 subjects are required (Cohen, 1988). An alternative analysis, the three-way ANOVA will be conducted. All results of the study will be obtained using the SPSS 11.5 software.

The research questions are:

1. Are there significant differences in mathematics achievement between male and female public elementary schools student in the Roseau zone differ?

2. Are there significant differences in mathematics achievement among urban, rural and deep rural male and female students in public elementary schools?

3. Does the mathematics achievement of male and female elementary school students differ significantly within districts (southern, eastern and western) of Roseau catchment area?
Descriptives for Mathematics Achievement by Gender, Geographic Location, and District

A total of 262 males and 174 females sat the CEE in the Roseau zone in 2003. Table 4 shows the means and standard deviation of mathematics score for males and females.

Table 4
Measures and Standard Deviation of Mathematics for Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Mean Math Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>262</td>
<td>32.19</td>
<td>11.24</td>
</tr>
<tr>
<td>Female</td>
<td>174</td>
<td>34.25</td>
<td>9.86</td>
</tr>
</tbody>
</table>

The sample for the analyses comprised 60.1 and 39.9 percent male and female students respectively, revealing a significantly greater number of boys as girls. Figure 1 represents the histogram for mathematics scores for the total sample. The mathematics scores do not deviate significantly from the normal curve, it appears to be normal, but however, the K.S rejected the null hypothesis that the distribution of
scores is normal. There were no outliers or influential points as all standardized scores for the dependent variable fell between –2.31 and 2.28. The criterion used for determining outliers was the standard score less than the absolute value of three (Stevens, 1999).

Figure 1. Histogram of Distribution for Raw Mathematics Scores
Sex of student

Figure 2. The distribution of the mathematics scores by gender

Table 5

Means and Standard Deviation for Mathematics by Geographic Location

<table>
<thead>
<tr>
<th>Geographic Location</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>170</td>
<td>34.5</td>
<td>10.78</td>
</tr>
<tr>
<td>Suburban</td>
<td>133</td>
<td>33.6</td>
<td>10.46</td>
</tr>
<tr>
<td>Rural</td>
<td>86</td>
<td>30.6</td>
<td>10.48</td>
</tr>
<tr>
<td>Deep-Rural</td>
<td>47</td>
<td>30.6</td>
<td>11.11</td>
</tr>
</tbody>
</table>
Table 5 shows the mean and standard deviation of mathematics scores for urban, suburban, rural and deep rural zones. The mean mathematics achievement score for the rural and deep rural are slightly lower than the urban and suburban zones, however the standard deviations of the four groups do not differ significantly. The mean mathematics score for the females are 36.1, 35.9, 29.6, and 33.4 in the urban, suburban, rural and deep rural zones, while the mean mathematics score for males are 33.5, 32.2, 31.2, and 28.1 for the urban, suburban, rural, and deep rural zones respectively. Although the urban /rural mean mathematics scores are relatively close in value, Figure 3 shows marked difference on the gender level. There are 39.7, 30.5, 19.7, and 10.8 percent of urban, suburban, rural and deep rural students respectively.

Figure 3. Distribution of students by gender and location
Table 6 shows the distribution of students by district. There are 33.5, 55.7, and 10.8 percents of students in the southern, western, and eastern zones respectively. The western zone consists of the majority of public elementary school students a total of 243. The eastern zone consists of two public elementary schools that are both deep rural with a total of 47 students.

Table 6

<table>
<thead>
<tr>
<th>District</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>146</td>
<td>31.3</td>
<td>10.25</td>
</tr>
<tr>
<td>West</td>
<td>243</td>
<td>34.5</td>
<td>10.78</td>
</tr>
<tr>
<td>East</td>
<td>47</td>
<td>30.6</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Table 6 reveals that the mean mathematics score for the western district is larger than those of the southern and eastern districts.
Figure 4. Distribution of mathematics scores by gender and district.
Results of Gender Differences by Geographic Location

Table 7

Analysis of Variance for Gender by Geographic Location

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>MS</th>
<th>df</th>
<th>F</th>
<th>(\eta^2)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (G)</td>
<td>484.9</td>
<td>484.9</td>
<td>1</td>
<td>4.33</td>
<td>0.01</td>
<td>0.038</td>
</tr>
<tr>
<td>Geographic Location (GL)</td>
<td>1467.5</td>
<td>489.2</td>
<td>3</td>
<td>4.36</td>
<td>0.03</td>
<td>0.005</td>
</tr>
<tr>
<td>G x GL</td>
<td>467.4</td>
<td>155.8</td>
<td>3</td>
<td>1.39</td>
<td>0.01</td>
<td>0.250</td>
</tr>
<tr>
<td>Error</td>
<td>47974.7</td>
<td>112.1</td>
<td>428</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In analyzing the data, tests of independence, normality and homogeneity of variances were conducted. Levine test of homogeneity of variances indicated that it is likely that there is homogeneity of variances among the groups, \(F(7,428) = 1.48\), and \(p = 0.17\). A 2 x 4 Analysis of Variance was conducted to investigate differences in mathematics achievement among elementary school students within the Roseau zone in the 2003 CEE examinations. The ANOVA results in Table 7 reveal a significant main effect for gender and a non-significant interaction. For gender, \(F(1,428) = 4.33\), partial
\( \eta^2 = 0.01, p < 0.05 \) and geographic location \( F (3,428) = 4.36 \), partial \( \eta^2 = 0.03 \), and \( p < 0.05 \). For the interaction between gender and geographic location, \( F (3,428) = 1.39 \), partial \( \eta^2 = 0.01 \), and \( p > 0.05 \).

The calculated effect sizes show that a small proportion of the variance is accounted for by the main effects and the interaction and the Tukey multiple comparisons show a significant difference between urban and rural male and female students as it relates to mathematics achievement, \( p < 0.05 \).

**Results of Gender Differences by District**

The results of the 2 x 3 factorial ANOVA conducted to investigate district differences shows that the variance of the mathematics scores for gender in the east, west, and south are not significantly different. Levine’s test of homogeneity of variance reveals that the variance of the groups across districts is likely to be equal, \( F (5, 430) = 1.56 \), \( p = 0.17 \). There were significant main effects and a non significant interaction. For gender, \( F (1,436) = 4.65 \), partial \( \eta^2 = 0.01 \), \( p < 0.05 \). For district, \( F (2,436) = 6.22 \), partial \( \eta^2 = 0.028 \), \( p < 0.05 \). The ANOVA summary table (Table 8) shows that there is no significant interaction, \( F (2,436) = 0.39 \), \( p >0.05 \). The amount of variance explained by the independent variables is small although significant main effects were found.
Table 8

*Analysis of Variance for Gender by District*

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>MS</th>
<th>df</th>
<th>F</th>
<th>$\eta^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (G)</td>
<td>521.9</td>
<td>521.9</td>
<td>1</td>
<td>4.65</td>
<td>0.011</td>
<td>0.032</td>
</tr>
<tr>
<td>District (D)</td>
<td>1396.4</td>
<td>698.2</td>
<td>2</td>
<td>6.22</td>
<td>0.028</td>
<td>0.002</td>
</tr>
<tr>
<td>G × D</td>
<td>214.1</td>
<td>107.0</td>
<td>2</td>
<td>0.95</td>
<td>0.004</td>
<td>0.386</td>
</tr>
<tr>
<td>Error</td>
<td>48244.4</td>
<td>112.2</td>
<td>430</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As a result of finding significant main effects, the Tukey test was conducted. The multiple comparisons showed significant group differences between the southern and western districts, $p = 0.013$. There were no significant differences between the eastern and southern or the western and eastern districts. Two distinct homogenous subsets were extracted. One subset consisted of the southern and eastern while the other subset comprised of the western district. This means that there are gender differences in terms of mathematics achievement even within the districts.
Alternative Analysis: Results of Gender Differences within the Eastern District

Another analysis that is not part of the formal research study is the investigation of gender differences in mathematics achievement within the deep rural area. A one-way ANOVA will be used for this particular analysis. This situation is particularly interesting since all deep rural are located in the eastern district. The findings will be presented, analyzed and discussed as the formal parts of this study.

In an effort to maximize the information contained in the data provided, an alternative analysis that was not part of the formal study was performed. The eastern district comprises only deep rural schools and it would be interesting to analyze the mathematics achievement scores in terms of gender differences within this location. A one-way ANOVA was conducted at \( \alpha = 0.05 \), for a small effect size of 0.25 and power of 0.80. Cohen (1988) requires a sample size of 45 for 1 degree of freedom.

Table 9 shows the distribution of students within the eastern district. The numbers of boys and girls in the eastern district who sat the 2003 CEE are quite close. The eastern district provided the least number of candidates for the examination.
Table 9

Means and Standard Deviation of mathematics Scores

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>23</td>
<td>28.13</td>
<td>11.28</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>33.04</td>
<td>10.62</td>
</tr>
</tbody>
</table>

Table 9 shows a slightly higher mean, a medium effect size for mathematics score for females than males in the eastern district and the standard deviations for each group are not quite different. A one–way ANOVA was conducted to investigate gender differences within the eastern district that consists of only deep rural schools. Levene’s test of homogeneity of variances indicated that the variances of the groups are likely to be equal, $F (1, 45) = 0.33, p = 0.57$. KS test of normality revealed that the mathematics score for males and females are likely to be normal, $z =1.49, p =0.2$ for males and, $z =1.28, p =0.23$ for females.
Table 10

Analysis of Variance for the Eastern District

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>283.28</td>
<td>1</td>
<td>283.28</td>
<td>2.365</td>
<td>.131</td>
</tr>
<tr>
<td>Within Groups</td>
<td>5389.57</td>
<td>45</td>
<td>119.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5672.85</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10 shows the results of the Analysis of Variance for the Eastern district. The one-way ANOVA resulted in non-significant results for gender differences in mathematics achievement for the eastern district. The ANOVA results $F (1, 45) =2.37, p =0.13,$ indicates that male and female students in the eastern district which comprises rural schools students are not likely to be different in mathematics achievement.

*Alternative Analysis: Results of three-way ANOVA*

A three-way ANOVA was conducted as an alternative analysis to investigate gender differences in mathematics achievement on the 2003 CEE as factors of geographic location and districts. Levene’s test of homogeneity of variances concludes that the variance of the mathematics scores is equal across groups, $F (9,426) = 1.57, p = 0.12.$ There is an overall gender difference in mathematics
achievement on the 2003 CEE, girls have outperformed boys. For sex, F (1, 426) = 4.96, partial $\eta^2 = 0.012$, $p < 0.05$. The univariate tests for geographic location and district reveal gender differences along these dimensions. There is significant difference within location, F (3, 426) = 4.30, partial $\eta^2 = 0.029$, $p < 0.05$. The mathematics achievement of urban and rural and the urban and deep rural male and females are significantly different $p = 0.002$ and $p = 0.017$ respectively. The suburban performance is significantly different to the rural performance $p = 0.019$. Among the districts, there are significant differences, F (2, 426) = 5.11, partial $\eta^2 = 0.023$, $p < 0.05$. These differences are between the south and west, $p = .009$, and the west and east, $p = 0.013$. However, there was no significant three way interaction.

Conclusions

The major purpose of this study was to investigate gender differences in mathematics achievement among public elementary school students of the Roseau zone in Dominica. These differences were investigated in respect to gender, geographic location, and district. The study also investigated gender differences in the eastern district that comprises all deep rural schools.

The students who sat the 2003 CEE were all sixth graders between the ages of 11 to 13. The CEE is a high-stake high school entrance examination that consists of mathematics, science, social studies, and English language. Mathematics achievement was the raw score that each student received after completion of the examination. The examinations are held annually and are done in all districts within a two-day period.
The review of literature indicated that students may be classified into a specific cognitive level based on age and the students who sat the 2003 CEE may be in the stage of concrete operations. Based on the theory, if the CEE is age appropriate, students at this stage of development, during the ages of eleven or twelve and onward, have develop the reasoning and logic to solve all classes of problems and that all students who have developed normally are able to sit the CEE and be eligible for placement in secondary schools.

This present study revealed that boys and girls in Dominica perform differently. As gender differentials on the mathematics subtest of the 2003 CEE do exist in Dominica, it is the girls rather than the boys who appear to do better. A gender difference in mathematics achievement on the 2003 CEE and this study further supports the fact that, in the Caribbean, females are outperforming males. However, the results of this study contradict the gender research done in the US and other industrialized countries where it has been shown that males do better than females in mathematics achievement.

The literature concerning the urban, suburban, rural divide in mathematics achievement showed that the research from the US and industrialized countries indicate that urban students perform better than rural and deep rural students in mathematics. This study also revealed a rural-urban gap in mathematics achievement on the 2003 CEE. The research in the Caribbean, though scarce, also reiterates the observed trend in the US and other industrialized countries. In
Dominica, urban students have surpassed their rural counterparts in mathematics achievement in the 2003 CEE.

The raw mathematics scores of the 436 male and female students of the public elementary schools that feed unto the Roseau zone were analyzed. The results of the statistical analyses show that there exists an overall gender difference in mathematics achievement. In the 2003 CEE, female students outperformed their male counterparts. There also exists a performance gap between male and female students of the urban and rural schools of the Roseau zone.

The analysis of the students of the western district will be of particular interest to the division of evaluation of the Ministry of education since education officers are responsible for schools on a district level. The study reveals a performance gap between the western, eastern and southern districts. The results reveal a mathematics gap between the western and eastern and the western and southern districts.

The alternative analysis done within the eastern district reveals no gender difference in mathematics achievement in the deep rural cohort. This is an interesting development since there is an overall gender difference in mathematics achievement on the 2003 CEE examination in Dominica.

The inequity in performance between male and female, rural and urban and the western, southern, and eastern districts has implication for mathematics education and future testing in the Commonwealth of Dominica.
Recommendations for Practice

Findings presented suggest that differences do exist in mathematics achievement as it relates to gender, geographic location, and district in Dominica. The results of this study have implications for teacher trainers, classroom teachers, and the curriculum development unit whose responsibility is educational policy development and testing.

Based on results generated by the CEE data, teacher trainers must become familiar with research and relevant theories pertaining to gender effects on educational attainment and be prepared to educate pre-service and in-service teacher in how to effectively combat the forces that create these differences at the lower elementary levels. Training should incorporate the teaching of learning styles and should sensitize trainees/teachers to gender differences in math achievement and motivation. Teacher trainers should equip trainees with techniques geared at counteracting societal expectations of males and females. Trainees must also be sensitized to gender cues used in classrooms and should be aware that these cues are sometimes subconsciously introduced into the classroom. Additionally, trainees should be exposed to relevant and up to date research on mathematics achievement especially as it has been shown that gender differences exist in Dominica. Trainees should be made aware that boys and girls learn differently and should be equipped with the pedagogical skills to teach in a gender neutral way. Training should encourage teachers to continually seek knowledge and to act as researchers in their
own classrooms and train teachers in research principles. Further more, teacher trainers need to sensitize incoming and veteran teachers through workshops and inservice training to issues pertaining to gender effects on mathematics achievement in a bid to eliminate the gap.

Given that boys and girls have different ways of thinking and learning, it is important that teachers acquire knowledge about these differences in order to provide appropriate gender-neutral educational experiences. Teachers should source information on their own rather than wait for such information to come along and it is possible that through action research, teachers within the classroom setting can identify and reduce the gender divide. In addition, teachers need to be aware of gender biases and how they negatively impact the learning process - especially for males, while gender specific language and approaches to problem solving should not form part of instruction. The differences in value systems between boys and girls should be regarded as valuable approaches to problem solving and should be considered to produce the best solutions to enhancing male achievement.

The curriculum division of the Ministry of Education, responsible for test construction should be sensitive to test biases and may from time to time perform analyses of test questions to identify the questions that may be biased towards males. It is important to recognize the need to write questions that reflect neutral experiences. The question banks should be continually revisited to ensure that the questions are applicable to and suited for all students regardless of gender, geographic location or district. The measurement and testing unit should develop a system aimed
at appraising parents of research findings on equality or inequality in achievement so that they too can play a role in eliminating unnecessary differentials. Finally, the division must be aware of the processes involved in test construction to determine question difficulty and discrimination that enables test constructors to eliminate or revise the questions that have not functioned adequately in the past. Finally, if the CEE is to be eliminated, after the implementation of USE, some system must be in place since gender differences are real and there is a need to have more males prepared for the educational challenge of secondary and tertiary education.

Recommendations for Future Research

In order to adequately explore gender, geographic location and district differences in mathematics achievement on the CEE in the Commonwealth of Dominica, it is important for future research to investigate or attempt a few of the following:

1. Examine personality variables or affective factors of students e.g. motivation, perseverance, self-confidence, self-perception, attitude toward mathematics, mathematics anxiety, utility of mathematics, and interest in school.

2. Have one on one interview with students asking them to explain how they solved problems where gender differences are known to exist may help shed light on the causes of these differences.

3. Conduct research of the environmental and social factors that enhance or impedes success in mathematics. Some of these factors include parental
involvement, parental expectations, aspirations, and educational level of parents.

4. School factors need to be investigated. These would include and are not limited to teacher quality, school resources, the curriculum, the academic climate within the institution, and class size.

5. The rural and district context can be explored in reference to the student, school, environment, teacher qualities, community and parental factors in order to understand why a gap exists in mathematics performance.

6. Research on deep rural schools can be done to investigate the reasons for the absence of a gender gap in mathematics. This may lead to the discovery of specific factors that discourage the gap in mathematics achievement in the deep rural area.

7. In future, factor analysis on the examinations (all subject areas) and reliability analyses on the subscales of the examinations should be performed. Of equal importance to future research will be to perform item and differential item function analyses in an effort to determine where the gender disparity exists along the subscales of the examination in mathematics.

8. By finding ways to identify the causes of male disparities in a bid to eliminate these differences, there would be a greater guarantee that male students would be more adequately prepared for success in the CEE and for entry into secondary school and tertiary institutions and onwards.
References


A determination has been made that the following research study is exempt from IRB review because it involves:

**Category 4** - research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens if publicly available or recorded without identifiers

**Project Title:** Gender Differences in Mathematics Achievement: An Analysis of the 2003 Common Entrance Examinations in the Commonwealth of Dominica

**Project Director:** Leandra D. Laidlow

**Department:** Education

**Advisor:** Gordon Brooks

Rebecca Cale, Associate Director, Research Compliance
Institutional Review Board

06/29/04

Date

The approval remains in effect provided the study is conducted exactly as described in your application for review. Any additions or modifications to the project must be approved by the IRB (as an amendment) prior to implementation.