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Variables Related to the Successful Completion of the First Course in Business Calculus at Three Jamaican Universities

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Andrews University
School of Education

VARIABLES RELATED TO THE SUCCESSFUL COMPLETION OF THE FIRST COURSE IN BUSINESS CALCULUS AT THREE JAMAICAN UNIVERSITIES

A Dissertation
Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

by
Martin Nkhrama Richards
April 2002
VARIABLES RELATED TO THE SUCCESSFUL COMPLETION OF THE FIRST COURSE IN BUSINESS CALCULUS AT THREE JAMAICAN UNIVERSITIES

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Martin Nkhrama Richards

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ABSTRACT

VARIABLES RELATED TO THE SUCCESSFUL COMPLETION
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by

Martin Nkrama Richards

Chair: Larry D. Burton
ABSTRACT OF GRADUATE STUDENT RESEARCH

Dissertation

Andrews University
School of Education

Title: VARIABLES RELATED TO THE SUCCESSFUL COMPLETION OF THE FIRST COURSE IN BUSINESS CALCULUS AT THREE JAMAICAN UNIVERSITIES

Name of researcher: Martin Nkhrama Richards

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Date completed: April 2002

Problem

Many students at all levels of the education system in Jamaica perform poorly at mathematics. In particular, the results of both the Caribbean Examinations Council and Business Calculus 1 at the university level have reflected a declining trend in mathematics performance in recent years.

Consequently, this study sought to investigate the variables related to the successful completion of the first course in business calculus at Jamaican universities. To this end, the study looked at perceptions of students and their professors regarding students' cognitive, affective, and professor effectiveness variables impacting success.
Method

The sample for this study consisted of 389 business calculus students and 12 professors from three Jamaican universities. The survey research method was used to ascertain the perceptions of the students and their professors. The Statistical Package for the Social Sciences was used to analyze the data by way of descriptive statistics, cross tabulation, chi-square, discriminant analysis, and the $t$ test for independent samples.

Results

Eleven hypotheses were tested to solicit from the students and professors their perceptions of the variables related to the successful completion of the first course in business calculus. Both successful and unsuccessful students and their professors perceived that certain cognitive, affective, and professor effectiveness variables were important for success in Business Calculus 1. However, they perceived that ability and relevance were not as important as the other variables.

Successful and unsuccessful students differed on the level of practice, relationship with fellow students, professor’s help, active class participation, professor’s clarity, use of calculus principles in everyday life, and out-of-class individual study required for success in Business Calculus 1. The students and their professors differed on the importance of relevance for success in Business Calculus 1.

Conclusion

This study suggests that students and their professors in the three Jamaican universities are cognizant that certain cognitive, affective, and professor effectiveness variables are important for success in Business Calculus 1. However, more needs to be
done to improve students' perceptions of their possession of these variables. In addition, the universities and their professors need to do more to enhance students' awareness of the relevance of Business Calculus 1 in particular and mathematics in general to everyday life.
To my parents, Surajah and Hermine Richards,
and my fiancée Tamara Morgan who have supported me wholeheartedly in reaching this milestone.
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CHAPTER I

INTRODUCTION

Background of the Study

Jamaica was a colony of Britain from 1656 to 1962, when it gained independence. During those years education was reserved for the privileged few. However, since independence, education has been gradually made available to the entire population, culminating with ‘free’ education in the 1970s. However, there are still a number of challenges to the education system.

The two basic skills emphasized by educators are literacy and numeracy skills. In particular, numeracy skills have been underdeveloped in many students at all levels of the educational process. It is common knowledge that many Jamaican young people leave school without the knowledge or foundation required for finding and holding good jobs. Many are not sufficiently numerate. They face the bleak prospect of dead-end work interrupted only by periods of unemployment.

More specifically, many students in Jamaica perform poorly at mathematics. The Caribbean Examination Council (CXC) examinations are required for admission to undergraduate business schools. The results of these examinations over the past several years have reflected a worrying trend in mathematics performance. In 1998-99 only 26.8% of the candidates who took the general proficiency level examinations were successful. Figure 1 shows a significant decline in performance relative to four
years earlier (1994/95), at which time the pass rate was 48.1%.

When compared with other subjects, mathematics performance has lagged behind. For Business Calculus 1 the results are also less than desirable. In some instances less than 50% success rate has been noted.

The result of this underperformance is that many Jamaican business students are unable to properly use calculus as a tool to solve business problems. While this is taking place, the workplace is demanding that graduates possess higher levels of analytical and problem-solving skills.

However, poor mathematics performance is not unique to Jamaica. In the United States, for example, of the 300,000 students enrolled in mainstream calculus 1 in 4-year colleges in the academic year 1986-87, only 140,000 were expected to be successful.
(Kasten et al., 1988). Additionally, approximately 23 million persons in the United States of America cannot compute at a functional level (Parnell, 1985).

**Statement of the Problem**

There is significant underperformance in mathematics at varying levels of the Jamaican education system. The CXC mathematics results and the calculus results at the tertiary level, in particular, reflect low and declining levels of mathematics performance. However, the literature is sparse regarding studies that address the reason for the underperformance in mathematics in Jamaica. In addition, not much research has been done to ascertain the reasons why some students succeed at mathematics. Consequently, this study seeks to learn from successful students their methods for success in order to combat the current underperformance in mathematics.

The emphasis of this study is on the variables related to the successful completion of the first course in business calculus from the perspectives of the students (Dewey, 1938; Piaget, 1970; Vygotsky, 1978) and their professors. The students' perceptions of these variables were the main focus of this research. It looked at a variety of factors identified in the literature such as: mathematics anxiety, critical thinking, thinking and problem-solving skills, mathematics ability, relevance of mathematics, practice, mathematics background, and attitude towards mathematics.

**Research Questions**

The general question examined is: What are the perceptions of students and their professors regarding the importance and possession of variables necessary for the
successful completion of the first course in business calculus. Answers were sought for the following questions:

1. What variables do students and their professors perceive to be important for success in the first course in business calculus?

2. Is there a significant difference in the perceptions of successful and unsuccessful students regarding the variables perceived necessary for successful completion of the first course in business calculus?

3. Is there a significant difference in the perceptions of successful and unsuccessful students regarding the degree to which they possess these variables?

4. Is there a significant difference between successful and unsuccessful students’ perceptions of their cognitive processes regarding Business Calculus I?

5. Is there a significant difference between successful and unsuccessful students’ perceptions of their affective factors regarding Business Calculus I?

6. Is there a significant difference in the perceptions of successful and unsuccessful students regarding the effectiveness of their Business Calculus I professors?

7. To what extent do the variables of mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, professor quality, cognitive factors, affective factors, and professor effectiveness differentiate between successful and unsuccessful students?

8. Do students’ attitudes toward Business Calculus I change after doing the course?

Research Hypotheses

Eleven hypotheses were used to answer the eight research questions.
Hypothesis 1: There is a significant difference between the perceptions of students and their professors in the three universities regarding the degree of importance of the dependent variables to the successful completion of the first course in business calculus.

Hypothesis 2: There is a linear combination of the independent variables regarding importance that significantly discriminates between Business Calculus 1 students and their professors in the three universities.

Hypothesis 3: There is a significant difference between the perceptions of successful and unsuccessful students in the three universities regarding the degree of importance of the dependent variables to the successful completion of the first course in business calculus.

Hypothesis 4: There is a linear combination of the independent variables regarding importance that significantly discriminates between successful and unsuccessful Business Calculus 1 students in the three universities.

Hypothesis 5: There is a significant difference in the perceptions of successful and unsuccessful students in the three universities regarding their degree of possession of the dependent variables considered necessary for the successful completion of Business Calculus 1.

Hypothesis 6: There is a linear combination of the independent variables regarding possession that significantly discriminates between successful and unsuccessful Business Calculus 1 students.
Hypothesis 7: There is a linear combination of the cognitive variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

Hypothesis 8: There is a linear combination of the affective variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

Hypothesis 9: There is a linear combination of the perceptions of professors' effectiveness variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

Hypothesis 10: There is a linear combination of all the variables (in hypotheses 1-9) that significantly discriminates between successful and unsuccessful Business Calculus 1 students in the three universities.

Hypothesis 11: There is a change of attitude after doing Business Calculus 1.

Purpose of the Study

As a teacher, I have been searching for more effective ways to enhance students' learning. Having been introduced to cooperative learning, it was enthusiastically implemented. However, some students' responses to cooperative learning, especially in Business Calculus 1, were below expectations. This lack of enthusiasm resulted in the realization that students must be interested in their own learning for even the best teaching methods to be effective. Learning involves a partnership between teachers, parents, and students (Arthur, 2000).

The American Psychological Association (APA; 1995) suggested that students' cognitive, metacognitive, motivational, affective, developmental, social, and individual
(differences) factors should be taken into account in order to enhance learning. *Learner-Centered Psychological Principles* (APA. 1995) suggests the following:

1. Learning is influenced by environmental factors, including culture, technology, and instructional practices—context of learning.

2. What and how much is learned is influenced by the learner’s motivation. Motivation to learn, in turn, is influenced by the individual’s emotional states, beliefs, interests, creativity, goals, and habits of thinking.

3. As individuals develop, there are different opportunities and constraints for learning.

4. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.

5. Learning is influenced by social interactions, interpersonal relations, and communication with others.

6. Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity.

7. Learning is most effective when differences in learners’ linguistic, cultural, and social backgrounds are taken into account.

However some studies about students’ performance/learning, in general and mathematics learning in particular, tend to ignore the students’ role in their learning. Consequently, this study focuses attention on the need for the learning of mathematics to be more student-centered.

Another justification for this study is that while other Jamaican studies (Clarke, 1979; Powell, 1994; Roach, 1978; Sadrak, 1985) have examined Jamaican students’
mathematics performance at different levels of the education system, none studied mathematics performance across all three Jamaican universities.

**Theoretical Framework**

A theoretical framework speaks to the various knowledge bases that underpin a topic and how the current study fits into the body of knowledge. C. Hart (1999) suggested that

a key element that makes for good scholarship is integration. Integration is about making connections between ideas, theories and experience. It is about applying a method or methodology from one area to another, about placing some episode into a larger theoretical framework, thereby providing a new way of looking at that phenomenon. This might mean drawing elements from different theories to form a new synthesis or provide a new insight. (p. 8)

This study draws on the theories of developmental psychology and successful intelligence. Developmental psychology is concerned with human changes that occur over time and the processes and influences that account for these changes. It looks at changes that define growth, maturation, and learning from birth to death (Lefrancois, 2000). Possibly the most basic of Piaget’s ideas, notes Von Glaserfeld (1997), is that human development is a process of adaptation to the environment and the highest form of human adaptation is cognition, that is, knowing.

Developmental psychology makes the following points. First, there are two main influences on human development: one’s genetic makeup and the environment in which one functions. This combination makes each person unique. Even though identical twins have the same genetic blueprint, they are still unique.

Second, although intellectual development follows an orderly sequence, the age at which various intellectual events occur can vary considerably from person to person.
depending on the environment. Piaget’s theory suggests that learning and development are highly interactive processes in which learners construct knowledge (Lefrancois, 2000). “In order to develop its full potential, every human brain needs the stimulation of an enriched environment” (Goad, 2001, p. 40).

Third, persons with intellectual ability in one area tend to do well in other areas. That is, abilities tend to correlate, not compensate. Fourth, culture determines what the end product of successful development is. It decides what is to be learned and what competencies need to be developed (Tappan, 1997; Vygotsky, 1992). Humans’ natural, unlearned capacities are gradually transformed into higher mental functions such as thinking and problem solving, mainly due to the influence of culture.

Developmental psychology explains the process by which students develop, beginning with their genetic makeup and continuing with their shaping through environmental influences. This theory explains students’ abilities, predispositions, anxieties, perceptions, meanings, cognitive abilities, knowledge, sense of relevance, and attitude toward studies. Learners come with varying background information, motives, and characteristics, such as gender, ethnicity, intelligence, and personality characteristics.

Sternberg’s theory of successful intelligence suggests a number of factors that are also relevant to this study. First, success is not just about learning well, but also about being skilled at selecting and shaping one’s environment. Successful intelligence involves purposively selecting and shaping of and adapting to environments relevant to one’s life. It requires a balance among selecting, shaping, and adapting to environments. Strengths are capitalized on and weaknesses are remedied or avoided by selecting the right environment. An intelligent person will select activities that are consistent with his
abilities and self-concept. Sternberg (1996) suggested that successful intelligence requires analytical, creative, and practical abilities—triarchic theory of intelligence. Analytical abilities include judging, evaluating, contrasting, comparing, and analyzing. Creative abilities involve generating options and ideas, and trying new ways of selecting and shaping the environment and adapting to it. On the other hand, practical abilities deal with carrying out options, and putting into practice behaviors and skills that are involved in selecting, shaping, and adapting to environments.

In summary, developmental psychology and successful intelligence theories are relevant to this study for the following reasons. First, this study is being done from the point of view that people’s success in life is dependent on their genetic makeup and the environment in which they develop. Second, people’s abilities (analytical, creative, and practical), fears, attitude, sense of relevance, choices, predisposition, and thinking skills are dependent on their heredity and environment. Finally, people’s success in life is impacted by their ability to select, adapt, and shape the circumstances around them. These choices are based on their practical, creative, and analytical abilities (see Figure 2).

**Significance of the Study**

This study was conducted because mathematical skills are basic and important for many endeavors. Mathematics is the foundation on which many other skills, such as logic and reasoning, rest. If mathematical skills are not developed, a person’s ability to function in today’s technology age is greatly hampered. The need for quantitative skills and the present underdevelopment of these skills in many Jamaican students make this research timely. History has shown that for a country to advance itself, its citizens
Student's genetic make-up: family traits, natural abilities, mental abilities, and others

Student's current traits: abilities, attitude, anxieties, predispositions, sense of relevance, diligence, thinking skills, and other traits

Past environmental factors: family, community, past academic success, friends, society, church, and others

Present environmental factors: family, community, university, church, friends, society, and others

Selecting, adapting to, and shaping the environment by using successful intelligence: analytical, creative, and practical abilities

Level of Success in Business Calculus 1

Figure 2. Process/cause-effect map of student's success.
need to be educated, especially in the quantitative area. Japan's rapid development since World War II is a good example of the importance of quantitative skills to technological and economic development (Cox, 1993; Thurow, 1987).

There has been concern, both in the United States of America and in Jamaica, regarding the low level of mathematics performance, particularly among high-school and university students. This underperformance affects the students' ability to fit into the job market.

Consequently, this study attempts to provide relevant information to students, educators, and university administrators about the variables related to the successful completion of the first course in business calculus. Business Calculus 1 provides the foundation for many upper-level courses and it is very critical for performance in an increasingly technologically advanced business environment.

It is hoped that through this study new ways may be found to improve students' quantitative skills and in turn improve the quantitative skills-level of Jamaican business school graduates.

**Rationale**

This study sought to discover the variables that relate to the successful completion of the first course in business calculus in three Jamaican universities in order that performance in this course may be enhanced. The focus was on university students because they will eventually form an important block of the workforce and their contributions affect the economic growth of a country. The first course in business calculus was examined because it provides the quantitative foundations and is a
prerequisite for other courses such as economics (Von Allmen, 1996), quantitative business analysis, production and operations management, and business statistics.

This study is based on the following assumptions:

1. There is a strong relationship between student variables and their performance in the first course in business calculus. If these variables can be identified in time, then, remedial measures may be taken in order to enhance performance.

2. Those Jamaican university business students and their professors who participated in this study were aware of the variables affecting the students' performance in the first course in business calculus.

3. Those Jamaican university business students and their professors who participated in this study provided reliable information regarding their perceptions of variables affecting the students' performance in the first course in business calculus.

4. The sample of business university students and professors used in this study was representative of the population of business students and professors in Jamaican universities.

Delimitations

This study was delimited in the following ways. First, the study examined variables related to the successful completion of the first course in business calculus from the perspectives of the students and their professors. Second, only three Jamaican universities were examined-no high schools were examined. Third, only Business Calculus 1 was studied, not calculus in general.
Limitations

Because the study was delimited to three universities, only 12 professors participated. In addition, another limitation of the study is that it focused on perceptions of students and professors, which are based on the participants' realities.

Definition of Terms

For the purpose of this study the following terms have these meanings:

Successful: In the context of completing the first course in Business Calculus, means getting at least a C grade.

Thinking skills: Being able to think critically, make decisions, solve problems, visualize, and know how to learn and reason (Caissey, 1990; Joyce & Voytek, 1996).

Mathematics anxiety: Factors that cause students to be nervous about the subject. These include test, evaluation, trait, state anxiety, gender, and level of mathematics ability (Rabalais, 1998).

Mathematics ability: A natural aptitude for mathematics.

Practice: The level of repetition involved in assimilating concepts and principles. It is related to diligence-effort expended toward a balanced development in one’s mental dimension (Bernard, 1991).

Problem-solving skills: The ability to assess a problem and devise a plan of action for its solution.

Mathematics background: The level of preparation in mathematics prior to enrolling into the first course in business calculus at a Jamaican university.

Cognitive factors: Knowing, understanding, problem-solving, and related intellectual processes. These include factors such as out-of-class group work, out-of-class...
individual study, active class participation, clarification of unclear issues with professor, use of principles in everyday life, analysis of principles, exploring new ways of solving problems, consistent study routine, and revision of principles.

**Affective factors**: Factors that relate to attitudes, emotions, or feelings as a result of experience which impact learning. These include professor's help, relationship with fellow students, class comfort, professor's fairness, professor's respectfulness, and university comfort.

**Professor quality/effectiveness**: Factors such as the professor's level of academic qualification, experience, competence, skill, and ability to generate interest in course. It also relates to the level of professor's clarity, ability to motivate, excellence, fun, encouragement, availability, and supportiveness in teaching and interacting with students.

**Past environmental factors**: Environmental influences, such as family, community, church, and friends, from birth to enrollment in the first course in business calculus.

**Present environmental factors**: Environmental influences, such as family, community, church, and friends, while enrolled in the first course in business calculus.

**Organization of the Study**

This dissertation is organized into five chapters. Chapter 1 is an introduction, which looks at the following: background of the study, statement of the problem, research questions, research hypotheses, purpose of the study, theoretical framework, significance of the study, rationale, delimitations, limitations, definition of terms, and organization of the study.
Chapter 2 deals with a review of the literature, which focuses on the following: the first course in undergraduate business calculus curriculum, variables affecting the successful completion of the first course in business calculus, innovative methods being used to teach/learn business calculus, the role of Business Calculus 1 in the undergraduate business curriculum, and standards for teaching mathematics.

Chapter 3 relates to the study's research methodology. The following are included: type of research, design of the study, samples, instrumentation, validity and reliability, pilot study, variables, data collection procedures, null hypotheses, analysis of data, and human subject considerations.

Chapter 4 outlines the analyses of the research findings. Here the various research questions and null hypotheses are examined.

Chapter 5 consists of the summary, discussion, interpretation, implications, and recommendations of the study. Finally, the appendix shows the various instrumentations used.
CHAPTER II

LITERATURE REVIEW

Overview/Introduction

This study examines variables related to the successful completion of the first course in business calculus at three Jamaican universities. However, due to the limited number of Jamaican resources found, this chapter reviews studies done mostly in the United States of America and other developed countries.

A review of the literature was done to ascertain the effects of selected variables on performance in the first course in business calculus. In addition, the literature was reviewed in order to understand the role of business calculus in the undergraduate business curriculum, the methods being used to teach and learn business calculus, and the standards regarding the teaching of mathematics, which includes business calculus. The review was conducted using the following media: electronic databases, research journals, periodicals, textbooks, dissertations, government statistics, and other sources.

The following sub-areas are addressed in this chapter: variables related to the successful completion of the first course in business calculus, standards for teaching and learning mathematics, innovative mathematics teaching methods, overview of current undergraduate business curriculum, and the role of calculus in undergraduate business education.
Critical Variables Affecting Performances in Undergraduate Business Calculus 1

Many studies have examined the variables affecting the performance of students in mathematics. In addition, many variables have been mentioned as affecting students’ performances. The variables in this study have been selected, in part, due to the emphasis placed on them by numerous studies (Cox, 1993; Fennema, Carpenter, Jacobs, Franke, & Levi, 1998; Fenton, 1991; Maysick, 1984; Rabalais, 1998; Wambach, 1993).

Additionally, based on my experience as a business calculus professor, these variables have been selected for examination of their effect on the successful completion of the first course in business calculus:

1. Mathematics anxiety
2. Attitude towards mathematics
3. Critical thinking–thinking and problem-solving skills
4. Mathematics ability
5. Mathematics background
6. Practice
7. Relevance of mathematics
8. Professor quality/effectiveness
9. Cognitive factors
10. Affective factors.

Mathematics Anxiety

Mathematics anxiety relates to factors that cause students to be nervous about the
subject. These include gender, test, evaluation, trait, state anxiety, and level of mathematics ability (Rabalais, 1998).

Females tend to be more anxious about mathematics than males even though they are not necessarily less capable of doing mathematics. Research showed that while males' and females' mathematics abilities are basically the same (Boli, Allen, & Payne, 1985; Haertel, Walberg, Junker, & Pascarella, 1981), females tend to believe that males are more capable at mathematics. This lower belief tends to reduce females' performance despite equal ability.

There is evidence that males do better than females on measures of mathematical skills, from very early in elementary school (Fennema et al., 1998; Robinson, Abbott, Berninger, & Busse, 1996). This difference often appears to increase at adolescence (Burkam, Lee, & Smerdon, 1997). However, the reasons for these differences are not totally clear. There is some evidence that girls use more concrete strategies while boys use more abstract approaches to solving problems, resulting in males performing better, especially with more advanced problems (Sowder, 1998).

Gender differences in mathematics are also closely related to culturally determined interest and motivation (Lefrancois, 2000). In many Western countries, adolescent girls are socialized to think that mathematics is a masculine subject, reserved for boys. For generations some Western societies have held the view that mathematics belongs in the male domain. Both students and teachers expect boys to do better in mathematics than girls. This low expectation of girls by significant others heightens their anxiety (Maysick, 1984). In addition, Smith (1981) found that females had low mathematics self-esteem, which contributed to their mathematics anxiety.

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On the contrary, studies undertaken in places such as Hawaii, with a more egalitarian view of gender, show mathematics performances of males and females that are opposite to those reported in North America. In those studies, girls usually outperform boys on standardized mathematics tests (Brandon, Newton, & Hammond, 1987).

However, much of the differences in mathematics performance between males and females noted in earlier studies such as Maccoby and Jacklin (1974) have declined significantly in recent times. In particular, gender differences among adolescents in academic areas have decline drastically in recent decades (Slate, Jones, Sloas, & Blake, 1998).

Test anxiety relates to the fear of getting wrong answers on examinations. This tends to be because mathematics is often seen as a 'right or wrong' course. Very often, more importance is given to the right answer than to the process by which it is obtained. Students may go through a tedious process correctly only to make a small error resulting in a loss of all the allocated marks. This need for 100% accuracy is stressful and causes anxiety (Maysick, 1984).

Trait anxiety relates to one's general anxiety level. It relates to how one normally reacts to stressful situations. Some people are naturally more anxious than others. Hence one can expect a highly trait-anxious person to be more anxious about mathematics than a low trait-anxious person. This type of anxiety tends not to be affected by one's present environmental influences (Maysick, 1984).

Unlike trait anxiety, state anxiety relates to one's anxiety level at a given time. This varies from time to time and depends on the person's current environmental and self-esteem situations. A person whose self-esteem is low at a given time would tend to
be more anxious about challenges such as mathematics than at another time (Maysick, 1984).

Finally, it may be concluded that poor past performance in mathematics leads to high levels of mathematics anxiety which correlates positively with ongoing poor performance. Conversely, good past performance tends to reduce mathematics anxiety, which correlates positively with successful future math performance (Maysick, 1984). However, a reduction in mathematics anxiety does not automatically lead to success (Smith, 1998).

Attitude Towards Mathematics

Attitude deals with confidence, motivation, level of belief in one's ability, and a general positive or negative feeling towards mathematics. Attitude tends to go a long way in affecting the accomplishment of any task-success. One's attitude determines one's altitude. "When our attitudes and perceptions are positive, learning is enhanced; when they are negative, learning suffers" (Marzano & Pickering, 1997, p. 13).

There are mathematics attitude scores that measure action, mood, feeling, and disposition towards mathematics. These scores correlate positively with mathematics achievement (Benbow & Stanley, 1982; Norma & Rendon, 1990). Likewise, when deficiencies in mathematics are corrected, attitude would relate to achievement (Joyce & Weil, 1986). Furthermore, attitude not only influences performance in mathematics but is also influenced by it (Wambach, 1993).

Smith (1998) suggested that the most important quality affecting students' success in mathematics is attitude. Attitude determines what one is willing to do in the course and it is the quality of effort that most significantly affects success. From his experience
he noted that even 'low-ability' students with good attitude who take the course seriously do well at mathematics while 'high-ability' students with poor attitudes tend to underperform.

In a study of students' performance in a preliminary course of mathematics at the University of the West Indies, it was found that those who passed showed very positive attitudes toward their work. They displayed determination to pass regardless of difficulties and did not see difficulties as having a negative effect on their ability to perform. The converse was true for those who did not pass (Sadrak, 1985).

Measures of attitude towards mathematics seem very similar for males and females and are often positive until high school years (Maysick, 1984). There is a moderately strong positive relationship between attitude towards mathematics and number of years of high-school mathematics for both genders. This suggests that college students' attitude towards mathematics is greatly influenced by high-school mathematics preparation (Betz, 1978). In addition, personality traits, which children bring to the academic setting, appear to be intricately related to mathematics scholastic attitudes (Williams, 1970).

A person's self-concept impacts his attitude towards mathematics. Many women have low mathematics self-esteem (Smith, 1981), which have a negative impact on their attitude towards and performance in mathematics. Self-estimated mathematics ability is also significant in determining attitude towards mathematics (Hendel, 1980).

Furthermore, motivation and the level of effort expended in learning are very important whether students are at college to learn and achieve academically or to pursue self-development (Bennett, 1994).
However, attitude does not always make a difference in mathematics performance. In a study of 118 students at Lake Michigan College, using the $t$ test to ascertain the difference in mean scores between the successful (65) and unsuccessful (53) students on the Aiken-Dreger Mathematics attitudes test, it was found that attitude towards mathematics of the two groups was not significantly related to achievement. There appeared to be no difference in mathematics attitude between successful and unsuccessful students with means approximately 39.4 and 38.6 respectively, and standard deviations of 16.1 and 16.7 respectively (Cox, 1993).

Critical Thinking

Thinking skills involve being able to think critically, make decisions, solve problems, visualize, and knowing how to learn and reason (Caissey, 1990; Joyce & Voytek, 1996). Critical, creative, and self-regulated thinking are productive mental habits that, along with attitudes and perceptions, form the backdrop of the learning process (Marzano & Pickering, 1997). These habits help students to be successful learners in any situation they encounter.

Critical thinking involves: being accurate and seeking accuracy; being clear and seeking clarity; maintaining an open mind; restraining impulsivity; taking a position when the situation warrants it; and responding appropriately to others’ feelings and level of knowledge. Creative thinking includes: perseverance; pushing the limits of one’s knowledge and abilities; generating, trusting, and maintaining one’s own standards of evaluation; and generating new ways of viewing a situation that are outside the boundaries of standard conventions. Self-regulated thinking includes: monitoring one’s own thinking; planning appropriately; identifying and using necessary resources;
responding appropriately to feedback; and evaluating the effectiveness of one's actions (Marzano & Pickering, 1997).

Furthermore, reflective thinking promotes learning and success by encouraging students to analyze their thoughts and experiences, and to create meaning from them. It releases the human spirit and leads to creativity. With reflective thinking one is moved from the primary concern with product to a concern with process (Kish & Sheehan, 1997).

Mathematics Ability

Ability is a key ingredient for success. Lavin (1965) noted that ability measures are the best single type of success predictors. For purposes of this study, this variable means a native aptitude for mathematics. This definition is similar to mathematical intelligence in the theory of multiple intelligences (Gardner, 1983). Gardner (1983) defines this intelligence as special insights into the realm of numbers, groups, objects, quantity, and operations (adding, subtracting, multiplying, and dividing). This ability is reflected early in a child's development through an aptitude to confront objects and order and reorder them, and being able to assess their quantity. After this stage mathematical abilities are usually far removed from the world of material objects.

As a person with this ability develops, he or she reflects a natural ability to: appreciate the actions that can be performed upon objects, the relations that obtain among those actions, the statements (or propositions) that one can make about actual or potential actions, and the relationships among those statements. Over the course of development, a person goes through the following related sequential stages: from objects to statements,
from actions to the relationships among actions, from sensory-motor to pure abstraction, and finally, to the heights of logic and science (Gardner, 1983).

Piaget (1954) suggested in his theory of cognitive development that mathematical ability develops in stages. He noted the following stages with their approximate ages: sensorimotor, 0-2; pre-conceptual, 2-4; intuitive, 4-7; concrete operations, 7-11; and formal operations, 11-15.

During the early sensorimotor stage, children believe that objects exist only when they can be sensed. By around age 1, they acquire the object concept—they are able to appreciate the continued existence of objects when they are not being immediately sensed.

However, Gelman (1982) and Gelman, Meck, and Merkin (1986) disagree with Piaget and suggest that during this stage children have number abstraction skills and are able to use numerical reasoning principles. Number abstraction skills include one-on-one, stable order, cardinal order, and order irrelevance principles, whereas numerical reasoning principles relate to the knowledge that allows children to reason about or predict the outcome of simple numerical operations such as addition and subtraction.

The next stage is called pre-operational, and it consists of the pre-conceptual and intuitive stages. In the pre-conceptual stage, children move from a purely perceptual and motor representation of the world to a more symbolic representation. However, they still cannot identify classes of objects and they usually reason transductively. On the other hand, children in the intuitive stage are able to think more logically even though their thinking is still largely perceptual rather than by reason and they still have classification problems.
At the concrete operations stage, children move from pre-logical form of thought to thinking governed by rules of logic. Their thought processes apply only to real, concrete objects and events and they have the ability to conserve. Additionally, they can apply rules of logic to classes, relations (series), and numbers.

Lastly, during the formal operations stage, children move from concrete objects and events and can relate to hypothetical situations. Their thinking tends to involve a formal set of logic and abstract relations.

However, it has been suggested that some people remain at the concrete stage, while others never even move beyond the intuition stage (Papalia, 1972; Rubin, Attewell, Tierney, & Tumolo, 1973).

Arguably, the most central feature of a person who is mathematically gifted is the ability to skillfully handle long chains of reasoning. Many mathematicians stated that they could sense a solution, or a direction, long before they worked out each step in detail. Second, speed and power of abstraction in the mathematically sphere are usually evident in the mathematically talented person. Lastly, a person with mathematical ability is able to recognize significant problems and then solve them readily.

However, everyone has varying levels of innate mathematical ability, which will impact their performance. While having a high aptitude for mathematics will lessen the effort required for success, it does not guarantee success. Even though ability has been established as a predictor which is significantly correlated with success, this is only so when other predictors (such as diligence) are added to it in predicting final success (Bennett, 1994). A person with mathematical ability will need to exercise the appropriate level of diligence to maximize the benefits of his ability. Ability and diligence (effort)
are not naturally correlated (Arthur, 2000; Bernard, 1991; Bernard & Thayer, 1993; Bernard, Thayer, & Streeter, 1993).

Mathematics Background

Mathematics background, in this study, relates to the level of preparation in mathematics prior to enrolling in the first course in business calculus. A significant part of this preparation relates to high-school mathematics courses taken and how these courses were taught. Many studies have noted the significance of high-school mathematics course background on future mathematics performance (Austin-Martin et al., 1980; Calvert, 1981; Hendel, 1980; Maysick, 1984).

Some students in my Business Calculus 1 classes, over the years, noted that much emphasis was not placed on application in their high school mathematics classes. As a result, these students tend to encounter difficulty trying to make the transition in thinking required for the first course in business calculus—which uses mathematics to solve practical business problems. Furthermore, some of my students noted that they learned mathematics by rote without the understanding required for application-type questions. This rote learning makes transfer of knowledge difficult.

Furthermore students retain little of what is covered in basic quantitative courses such as calculus. In addition, students may not understand much of what they manage to retain (Rustagi, 1997). This results in many students not being well prepared for the first course in business calculus at universities (Fenton, 1991). Moreover, even some high-school students who are preparing for college do not take calculus (Kasten et al., 1988).

Background knowledge is very important to the learning of business calculus. Neuroscience research discovered that life experiences and previous learning make
learning possible and long lasting (Lopez & Alipoon, 2001). Therefore, professors need to be keenly aware of what students already know, and what is likely to be meaningful and interesting to them (Johnson, 1996), since learning is hierarchical—higher-order skills and concepts depend on subordinate capabilities (Gagne, 1985).

Lefrancois (2000) noted that Thorndike's law of readiness suggested that previous learning is clearly significant in determining whether learning is easy, difficult, or impossible. The learner's readiness often determines whether a learning experience is pleasant or not. A learner who is ready for a specific type of learning is far more likely to profit from such learning experiences than another who is not. Readiness may depend on the development of intellectual skills and on the acquisition of important background information (Lefrancois, 2000). Although the correlation between intelligence test scores and school achievement is substantial, previous achievement correlates even more highly with future achievement than these scores (Cohen, 1972; Thorndike & Hagen, 1977).

In a study conducted at California's Orange Coast College, involving 131 students who were doing business calculus, it was found that students who completed college algebra prior to enrolling in business calculus performed significantly better than those who did not: mean scores, on a 4-point grade point average, of 3.014 compared with 2.541 (Arismendi-Pardi, 1997). Keeley et al. (1994), in their study of the relationship between high-school background and college mathematics achievement, found that high-school class rank was a predictor of college mathematics achievement.

These results were also borne out in a study of 1983 entrants in the faculty of Natural Sciences at the University of the West Indies, where it was found that
mathematics passes were positively correlated with academic background in the subject (Sadrak, 1985).

Tyler (1949) suggested that background is important for successful learning, when he talked about the need for sequence in learning experiences. He noted that each successive learning experience should build upon the preceding one but go more broadly and deeply into the contents involved. The idea of mastery learning also underscores the significance of sound background to successful learning. It suggests that higher-level learning should not be undertaken until lower-level tasks are mastered (Bloom, 1971).

Finally, mathematics, more than many other courses, is a cumulative course. What is taught at an earlier grade must be learned or else what is taught later cannot be learned. It is also a progressive course. It usually gets more challenging in higher grades (Maysick, 1984). Hence, a sound background is more important for success in mathematics than many other courses.

Practice

Practice relates to the level of repetition involved in assimilating concepts and principles. The knowledge base of business calculus is largely procedural, requiring knowledge of steps and procedures. When students are learning a process, they should practice it immediately and frequently; that is, they should engage in massed practice (Marzano & Pickering, 1997). Professors should ensure that students practice concepts, since this helps make the neural pathways more efficient (Jensen, 1998). Rehearsals enhance permanent storage and efficient retrieval of information (England, 2001). Procedural knowledge is best assimilated by continuous practice–rehearsal. Students
often complain that they understand the concepts in class, but that they have difficulty with them after time has elapsed.

Relevance of Mathematics

This variable speaks to how important students regard business calculus for preparation for life in general and employment in particular. Culture determines what the end product of successful development is. It decides what is to be learned and what competencies need to be developed (Tappan, 1997; Vygotsky, 1992)—it determines relevance. Many business students think that calculus is too abstract and hence it is not important for functioning in society. They believe that the computer can solve many of their quantitative challenges. When students perceive calculus as irrelevant they have difficulty succeeding at it since the brain is open only to what it perceives as relevant (Diamond & Hopson, 1998; Marzano & Pickering, 1997).

Students also tend to devalue (consider irrelevant) mathematics competencies if they had a previous bad experience with mathematics. They reason that, if mathematics is unimportant, it does not matter how well one does at it (Meece, 1981).

However, mathematics is relevant to many educational domains. Disciplines such as psychology, politics, sociology, and economics have been increasingly mathematicised. Even laymen need to understand mathematics in order to survive and function in society. In Jamaica, interactions with apprentices, workmen, supervisors, and instructors have highlighted the importance of mathematics to many occupations. Job advertisements in Jamaica also reflect the need to have knowledge of mathematics to be considered for many jobs.
Many Jamaican tertiary institutions also require mathematics for matriculation purposes. Consequently, at a minimum, students must understand the area of mathematics most relevant to them so that they can function in the world in general and in their chosen field in particular.

However, many mathematics educators believe that traditional mathematics education is inadequate for present and future societal mathematics requirements. They note the urgent need for more meaningful programs and acceptable teaching principles. In addition, there are significant concerns regarding the pre-college mathematics curriculum. The curriculum needs to extend far beyond preparing the top 20% of high-school students for tertiary education. Instead, more focus should be placed on high-school graduates' preparation for the workplace. Lastly, some traditional mathematics topics are criticized by modern advocates as being obsolete and irrelevant to present-day societal problems and should therefore be de-emphasized (Clarke, 1979).

Professor Quality/Effectiveness

Professor quality relates to professor’s level of academic qualification, experience, competence, skill, and ability to generate interest in course. It also relates to the level of professor’s clarity, ability to motivate, excellence, fun, encouragement, availability, and supportiveness in teaching and interacting with students. High-quality professors excel at teaching; possess a high level of content and pedagogical knowledge; perceive meaningful patterns and relationship in their teaching; are highly efficient in responding to students and making rapid teaching decisions; devote considerable time to analyzing teaching problems; are skillful at monitoring and evaluating teaching behaviors; arrive at insightful solutions for pedagogical and management problems; and

Effective professors are also engaged in purposeful teaching. A review of British and North American research literature found that purposeful teaching involves efficient organization, clarity of purpose, structured lessons, and adaptive practice (Sammons, Hillman, & Mortimore, 1995). On the contrary, professors are considered ineffective if the following occur in their classrooms: low levels of work discussion, low levels of professor-student interactions, low levels of students' involvement in work, and students' perceptions of professors as people who do not care or provide help (Mortimore, Sammons, Stoll, Lewis, & Ecob, 1986; Teddlie & Stringfield, 1993).

A year-long study of 72 teachers of third- and sixth-grade mathematics and language arts found a positive relationship between student achievement and the following effective teaching behaviors: clarity in presentation; use of a variety of instructional techniques and adapting instruction to meet learning needs; motivating students; caring, accepting, and valuing students; encouraging students; ensuring interesting and worthwhile assignments; and facilitating class participation (MacKay, 1982).

Professor effectiveness is also measured by students' outcomes. Professors whose students are tolerant, caring, responsible, critical thinkers, and problem solvers are considered effective (Drake, 1995; Spady, 1994). Lastly, students want teachers who care, exhibit humor, and show consideration and respect (Phelan, Davidson, & Hanh, 1992).
Cognitive Factors

Cognitive factors relate to knowing, understanding, problem solving, and related intellectual processes. They include factors such as out-of-class group work, out-of-class individual study, active class participation, clarification of unclear issues with the professor, use of principles in everyday life, analysis of principles, exploring new ways of solving problems, consistent study routine, and revision of principles.

Regardless of teaching method, lack of time spent on task results in underperformance. It was found that successful students spent much more time working on course work at home, while less successful students did work only during class. The more successful students spent much of their class time asking questions and clarifying issues (Cox, 1993).

Affective Factors

These are factors that relate to attitudes, emotions, or feelings as a result of experience which impact learning. These include professor’s help, relationship with fellow students, class comfort, professor’s fairness, professor’s respectfulness, and university comfort. They all affect student’s self-concept, that is, his belief about himself. Self-concept is the product of a multiplicity of interactions with significant others such as professors. These factors are very important for success. “All learning takes place against the backdrop of learners’ attitudes and perceptions” (Marzano & Pickering, 1997, p. 7).

Researchers have suggested for years that there is a direct relationship between how students feel about themselves and their academic achievement (Stoll & Fink, 1996).
However, the relationship between self-concept and learning has been a controversial area in educational literature (Kohn, 1994).

Professors who were seen by students as people who did not care or provide help were considered ineffective (Mortimore et al., 1986; Teddlie & Stringfield, 1993). However, there was a positive relationship between student achievement and professors’ caring, accepting, valuing, encouraging, and motivating students (MacKay, 1982). MacKay also noted that when professors respond accurately to students’ feelings and experiences, achievement is improved. Students learn more when they see themselves as able, responsible, and worthwhile. In addition, when schools facilitate affective development, cognitive development is enhanced (Purkey & Asby, 1988). Students suggested that interaction between students is essential for building supportive work environment where success may be achieved. They want teachers who care, exhibit humor, and show consideration and respect (Phelan et al., 1992).

Emotional intelligence is another critical affective factor. Among other dimensions, it relates to self-awareness, managing emotions, handling relationships, and motivation. Self-awareness relates to understanding, knowing, and being able to express feelings that are the basis of self-esteem and self-confidence. Managing emotions deals with one’s ability to handle upsetting feelings and impulses. Handling relationships looks at being able to communicate, get along with others, resolve conflicts, and being more cooperative and helpful. Motivation deals with having goals, knowing what is required to reach those goals, and having the persistence to follow through. It may be concluded that emotional intelligence is the ‘essential foundation’ for all learning (Goleman, 1996).
Role of Business Calculus in the Undergraduate Business Curriculum

The emphasis of the undergraduate business curricula today is on equipping students with employable skills, so they can make a smooth transition to the working world (Bishop, 1995). Many business undergraduate schools have become vocationalized (Hammon, Hartman, & Brown, 1996; West & Aupperle, 1996). Business schools have been forced to focus on relevant student outcomes that are acceptable to employers and students in order to remain viable entities (Van Horn, 1995; Wallhaus, 1996). Professors are regarded as being effective when students see them as making the connections clear between theory and what is done in the workplace (Candy & Crebert, 1991). However, both academia (Useem, 1995) and the business community (Jones, 1996) have criticized the vocationalism within the undergraduate business curriculum. Notwithstanding these criticisms, vocationalism is still the emphasis today.

One significant aspect of undergraduate business curricula is the need to train future workers who have quantitative skills (Levenburg, 1996). Central to this process is the first course in business calculus, which not only seeks to develop quantitative skills, but also provides the foundation for the development of higher-level quantitative skills through courses such as quantitative business analysis and statistics.

Business calculus also contributes to the undergraduate curriculum by helping to develop the thinking and problem-solving skills of students. These are important skills required by employers; they are interested only in graduates who can analyze, assess, evaluate, compare, and contrast. It is felt that graduates who possess these skills within their repertoire of employability skills are better able to work independently of others as well as effectively within groups (Williams, 1998).
The First Course in Business Calculus

Calculus is among the top five collegiate courses in annual enrollment. In the academic year 1986-87 there were more than 300,000 students in mainstream calculus 1 and approximately 260,000 in business calculus in the United States (Kasten et al., 1988). Every business student is required to take the first course in business calculus. This course is usually taken in the first or second semester of university enrollment, after doing an algebra course. In a study conducted at California’s Orange Coast College involving 131 students who were doing business calculus, it was found that students who completed college algebra prior to enrolling in business calculus performed significantly better than those who did not: mean scores, on a 4-point grade point average, of 3.014 compared with 2.541 (Arismendi-Pardi, 1997).

Business calculus is sequenced early in undergraduate business curriculum due to the fact that it is a pre-requisite for many courses such as economics, business and economics statistics, quantitative business analysis, production and operations management, and financial management (Kasten et al., 1988). The rationale is that business calculus would develop relevant skills such as quantitative, critical thinking, problem solving, creative thinking, reasoning, analytical, and presentation skills, which are required for these courses. In addition, these skills are essential to the job market (Caissey, 1990; Joyce & Voytek, 1996; Levenburg, 1996; Van Horn, 1995).

Business calculus at universities tends to include topics such as algebra (revision), differentiation, and integration. These topics are usually learned in a business problem-solving context: that is, application problems. This emphasis on application often presents challenges to students most of whom learned mathematics the traditional way in
high schools, that is, rote learning with emphasis on memorization and not much emphasis on thinking, problem solving, and reasoning. Consequently, many students have difficulty making the transition. They consider business calculus difficult, which results in a high dropout rate. Only 140,000 of the initial 300,000 students enrolled in Calculus I at the college level (in the United States) in the academic year 1986-87 were likely to successfully complete their courses (Kasten et al., 1988).

Standards for Teaching and Learning Mathematics

International Perspective

The Third International Mathematics and Science Study (TIMSS) found that U.S. students were not competitive with students from other countries. The United States ranked 28th among 41 countries in a 1997 U.S. Department of Education study. When the U.S.A. was compared with third-ranked Japan, it was found that U.S. students spent much less time on thinking activities than their Japanese counterparts (60% compared to 24%). In addition, it was found that Japanese students spent 41% of their class work time on practicing procedures, 15% on applying concepts, and 44% on inventing and thinking activities, as opposed to their U.S. counterparts, who spent 96% of their class time on practicing tasks and little or no time applying concepts or doing activities involving thinking and inventing (U.S. Department of Education, 1997).

The U.S. Office of Educational Research and Improvement (1996) in summarizing TIMSS placed blame on the U.S. mathematics standards. Their report stated that the U.S. standards were unfocused and were aimed at the lowest common denominator. They were too broad and lacked sufficient depth.

Poor mathematics performance is not restricted to the United States of America.
Malaty (1998) noted that mathematics education is a worldwide problem spanning both Eastern (primarily Russia) and Western (primarily U.S.) countries. One aspect of this problem is the teaching of mathematics. He noted that while the West has been making beneficial changes, the changes in the East were likely to be more problematic.

U.S. Standards—National Council of Teachers of Mathematics (NCTM)—Overview

Since the Nation at Risk (U.S. Department of Education, 1983) shocked Americans, mathematics education has received much attention. Efforts have been made to correct the poor mathematics performance of students, highlighted in the report. At the forefront of the reform movement, to correct this problem, is the NCTM. NCTM has produced four standards documents released in 1989, 1991, 1995, and 2000. The 1989 standards made recommendations regarding what should be taught in schools and how mathematics programs should be evaluated. The standards between 1991 and 2000 looked at teaching and student assessment.

These standards were developed in response to a number of perceived needs: the need for a mathematically literate workforce; the need for members of society to be lifelong learners so they can adapt to a rapidly changing world; the need to create educational and professional opportunities for all students; and the need for an electorate that is capable of interpreting quantitative information (Hodgson & Ballard, 2001).

The 2000 standards focused on teaching and student assessment, as do the 1991 and 1995 standards. It looks at fundamental mathematical content such as numbers and operations, algebra, and data analysis. It also looks at five process standards, namely representation, reasoning and proof, problem solving, communication, and connections.
Finally, it encourages constructivist approaches to teaching such as writing and speaking about mathematics, open-ended problem-focused methods, and cooperative learning. The main emphasis of the 2000 standard is on learning mathematics in a problem-solving context.

**NCTM–Process Standards**

For the U.S. and other countries to improve their international rankings, teachers must emphasize five important process standards: problem solving, reasoning and proof, communication, connections, and representation. First, problem solving speaks to being in situations where the answer is not known in advance, and students have to use their mathematical knowledge and construct new mathematical understanding and develop new problem-solving skills. Second, reasoning and proof deals with improving students' analytical thinking and perceptions of patterns and structure in real-life situations and mathematical abstractions. Third, the communication standard seeks to have students reflect on, refine, discuss, and change their thinking. Fourth, the connections standard addresses the need for students to learn about the interrelated nature of the entire field of mathematics. This should facilitate recognition and application of mathematics in various contexts. Lastly, the representation standard encourages the use of diagrams, graphs, equations, and other symbolic expressions. Mathematics class should help empower students to select, apply, and translate among different representations to solve problems (NCTM, 2000).
NCTM–Teaching Standards

The standards recommended a shift from the traditional lecture-type methods to more student-centered approaches such as discovery learning. They emphasize active student involvement in the learning of mathematics, writing and speaking about mathematics, negotiating for consensus in small groups, and open-ended problem-focused teaching. Mathematics should no longer focus on memorizing numbers and applying computational procedures, instead a conceptual understanding and the ability to reason and communicate with others should be emphasized (Shaw, Aspinwall, & Cove, 2001).

Benefits of NCTM Standards–Proponents

Shaw et al. (2001) believe that the Principles and Standards for School Mathematics (NCTM, 2000) does the following: sees teachers and students as thinkers, investigators, doers, and problem solvers; asserts that all students are capable of learning; encourages reflective teaching; and uses real-life situations to make links to mathematics.

Hodgson and Ballard (2001) feel that, for instance, the 1991 Professional Standards for Teaching Mathematics strongly supports the empowerment of students. They believe that students thrive in the sort of student-centered environment advocated by this standard.

Burrill and Kennedy (1997) noted that the recent standards have the following features: (a) they are directed at all students; (b) they emphasize understanding of fundamental content and processes, instead of mere memorization of facts and rote performance of algorithms; (c) beyond defining what students ought to know and do, they focus on assessment, teaching, professional development, programs, and system support;
and (d) they emphasize content more than curriculum, that is, they leave decisions about the structure, order, and organization of mathematics content to the states and local districts.

Proponents of these standards suggest that they address societal needs. Most importantly, according to them, they address the need for equity in mathematics education. All students are prepared to think and reason, not just a select few as occur with the traditional curriculum.

Criticisms of NCTM Standards

Some mathematicians believe that these standards leave students unprepared for the rigors of a university mathematics course (Hodgson & Ballard, 2001; Lundin, 2001). From an extensive study done on a standards-based curriculum it was found that, for a number of reasons, students in the traditional curriculum entered the university with better algebraic skills than their standards-based counterparts (Lundin, 2001).

Even though NCTM standards have been in place for almost 10 years, there is little evidence that American mathematics programs have changed appreciably (Hodgson & Ballard, 2001).

Kirst and Bird (1999) identified four main areas of tension caused by the standards. These are: between local control and political consensus; between the needs for specificity and flexibility; between new curricular goals and the ability of the educational system to incorporate them; and between educational authorities and the public’s understanding of what the new standards entail.
Jamaican Primary School Standards

Objectives

The Jamaican primary school standards for mathematics are based on the overall objective of heightened academic performance and achievement. They suggest that schools should apply these standards as a basis to install a quality assurance system, and to satisfy their customers, both within and outside the institutions, of the quality of education offered.

Principles

The principles and understandings underpinning the primary school standards include the following:

1. Learning is most effective when undertaken in a cooperative and interactive setting.

2. All students can and should be assisted to learn.

3. All students should be exposed to the best available curriculum and instructional methods.

4. Students' success should be rewarded and underperformance remedied.

Curriculum Standards

The Jamaican primary school standards are designed to satisfy the following desires:

1. All students should have the mathematical skills that they will require to be successful in their careers and daily lives.

2. The population should be numerate and not fear mathematics or its associated...
technology, but rather uses both effectively for the development of the nation.

In order to satisfy the required outcomes, the attainment targets specify that students should be able to do the following:

1. Solve real-world problems by using ratios.

2. Use computation, estimation, and calculators appropriately to solve real-world problems.

3. Design, use, and interpret graphs, charts, and tables.

4. Develop questionnaires, collect data, chart relationships, present findings, and interpret data.

5. Explore and analyze problems by gathering statistics from real-world situations.

6. Distinguish among and use the appropriate measures of central tendency and dispersion.

7. Explain and use the concept of chance (Jamaica Ministry of Education & Culture, 1999).

**Jamaican Secondary School Standards**

**Philosophy**

The philosophy notes that given the dynamic, technologically advanced, global village which the world is becoming, education should prepare students to face new and changing situations. Furthermore, since mathematics is a critical component in the education process it should reflect the objectives of education in a dynamic world.

In this information age mathematics education should emphasize higher-level skills such as communication, discussion, interpretation, and evaluation. New concepts
should be taught and understood in the context of students' real-life, practical experiences. In addition, mathematics education should de-emphasize the 'right-wrong' mould and focus instead on observation, discussion, relationship, analysis, and drawing conclusions based on environmental situations.

Curriculum Design

Based on the philosophy the curriculum for grades 7-9 is designed to achieve the following:

1. Develop students' mathematical knowledge through activities related to everyday life, by applying (mathematical) principles of investigating, reasoning, estimating, and through meaningful communication.

2. Enhance mathematical knowledge while establishing the inter-relationship of mathematics with other disciplines.

3. Foster self-awareness and self-confidence, appreciation of enquiry, independent thinking, willingness to share, and co-operation with others in the pursuit of knowledge.

4. Use instructional methods that encourage students to formulate their own problems and ask questions that signal their own understanding and interest instead of using only textbook situations.

5. Facilitate students' learning through mastery learning techniques that allow the students to be actively involved in their learning process and learn at their own pace.

6. Provide opportunities for a variety of instructional approaches such as individual, group, and whole class learning activities.
7. Provide opportunity for students to talk about and test their ideas, and listen to and evaluate their peers, thus helping them to develop their ability to communicate and reason. Figure 3 outlines the philosophy of the curriculum design.

Rationale

Mathematical skills develop in a sequential matter. Young children demonstrate these skills through discovery as they interact with objects in their environment. These skills, if properly harnessed, gradually develop into more logical, abstract, sophisticated mathematical competencies in later years. The teaching of mathematics seeks to develop these natural, creative abilities into logical conceptual mathematical competencies.

Mathematics is considered one of the "basics" of education and is therefore important in the developmental process. Consequently, problem-solving processes should be used to develop reasoning, application, logical, problem-solving, and other mathematical skills. These skills are important in people’s everyday lives as they interact in society, at the workplace, and in a technological world.

Goals and Objectives

The following goals and objectives have been established by the standard:

1. The development of a problem-solving approach to learning mathematics and the willingness to accept the challenges of new situations.

2. The development of creative, enquiry, testing, and generalization skills.

3. The development of the skills of estimation and approximation as means of establishing the reasonableness of answers.

4. The development of the understanding of mathematical concepts and the
Figure 3. Philosophical model. From Government of Jamaica/World Bank Reform of Secondary Education (p. 82), by Jamaica Ministry of Education & Culture, 1998, Jamaica: Government Printing Office.
ability to transfer this understanding to other situations within and outside the course.

5. The development of an awareness of the connectivity of mathematics with other courses.

6. The development of the ability to gather, discuss, interpret and evaluate data.

7. The development of the use of technology in the learning experience.


**Evaluation of Jamaican Standards**

The Jamaican primary- and secondary-school standards satisfy the following critical curriculum design standards noted by Wiggins and McTighe (1998): (a) they focus on the big ideas that are important for life; (b) they are specific enough to guide teaching and assessment; (c) they provide opportunities for students to demonstrate their understandings through authentic performance tasks; (d) they provide opportunities for students to explore the big ideas by way of inquiry, research, problem-solving, and experimentation; (e) they provide opportunities for students to rehearse, revise, and refine their work based on constructive feedback; (f) they provide explicit information on the knowledge and skills that students need in order to do what is required of them; (g) they provide information to students about where they are going and why; and (h) they provide sufficient information to support inferences about students’ understanding.

In addition, the Jamaican standards address the need for scope, sequence, and evaluation noted by Tyler (1949). Furthermore the standards emphasize constructivist approaches to teaching and are in board terms to facilitate flexibility in implementation.
However, the standards do not deal comprehensively with the following criteria outlined by Wiggins and McTighe (1998): (a) frame the curriculum objectives by using provocative essential and unit questions; and (b) allow for students' self-assessment and goal setting before the end of the term.

**Innovative Methods of Teaching Business Calculus**

Business Calculus like most other subjects has been affected by the dominance of the lecture method of teaching. Lecturing is currently the most common teaching method in universities, colleges, secondary schools, and elementary schools. Goodlad (1983) revealed that in the U.S.A. 92% of the time lecture/recitation is used in the classrooms. Similarly, Cienkus and Ornstein (1997) noted that lecture-type teaching has dominated North American classrooms for at least the last two centuries. And it still is the most common approach to instruction in learning institutions today.

However, there have been a growing number of persons advocating a more student-centered approach to teaching (Bloom, 1984; Brooks & Brooks, 1993; Bruner, 1973; Dewey, 1938; Gardner, 1983; Johnson, 1996; Piaget, 1961; Vygotsky, 1978). They propose a philosophy of teaching in which students are given a far more important role in curriculum decisions than has traditionally been the case. This teaching philosophy is called constructivism. Constructivism relates to teaching approaches that are student-centered and that reflect the notion that meaningful information is constructed by the learners rather than given to them (Lefrancois, 2000). Each learner personally deciphers the information presented to him and develops his understanding based on his schema. Constructivism includes approaches to teaching such as discovery learning, reciprocal learning, cognitive apprenticeship, and cooperative learning.
Since the Nation at Risk (U.S. Department of Education, 1983) shocked Americans about the poor state of mathematics education, the teaching of mathematics has received much attention. Much effort has been made to improve the poor performances of students in mathematics. At the forefront of the reform is the NCTM, which advocates the need for a shift from the lecture-type approach to more student-centered approaches. Since every student has a mind and these minds work in different ways, a variety of teaching and learning strategies is required to meet these differences (Stoll & Fink, 1996). The NCTM council has spent years creating guidelines for teaching mathematics. The latest version published in 2000 has suggested teaching methods such as cooperative learning, discovery learning, and hands-on encounters with mathematical concepts.

Cooperative Learning

Cooperative learning is simply cooperation in learning through pupil interaction in small groups. It covers the many ways of organizing the classroom instructions so that students work and learn in small groups—four to six members. There are five critical attributes of cooperative learning: positive interdependence, individual accountability, group processing, social skills, and face-to-face interaction. It has a strong theoretical and research base and has been proven to promote academic achievement, social-skills development, personal growth, improved inter-racial relations, and improvement in other interpersonal relationships (Jacques, Wilton, & Townsend, 1998; Johnson & Johnson, 1994; Stevens & Slavin, 1995).

Studies have examined the effect of cooperative learning on the learning of calculus (see for example Haruta, Turpin, & Mcgivney, 1998). For example, Fetta (1996)
has developed materials that outline how cooperative learning may be used to enhance the learning of business calculus. These materials emphasize group work that involves mathematical decision-making and interpretation of results in an active, constructivist environment. These materials are being implemented in a variety of postsecondary and secondary institutions.

Cooperative learning can have certain advantages over the traditional approach for some students. It provides opportunity for students to actively ask questions for better understanding; receive explanation from fellow students rather than "the teacher"; and encourages students to explain concepts to other students, an activity that can increase their self-confidence (Smith, 1998).

Haruta et al. (1998) conducted a 5-year study of a pre-calculus course for business and health professions majors, at the University of Hartford, and found that students benefited from using the group work approach to learning.

Similarly, Clarke (2001) noted the following benefits from using a cooperative learning approach in his university mathematics classes: students learned to talk comfortably about mathematics ideas and terminology; students learned to work together and respect other people’s opinions; the slower students got more individualized instruction than in a lecture session; the quicker students benefited as they helped others to understand the concepts; and cooperative learning significantly reduced students’ mathematics phobia.

A study done at Ohio State University involving 900 students, regarding the effect of cooperative learning on business calculus performance, showed a significant reduction
in the odds of failing the follow-up business calculus course by students coming from a cooperative learning pre-requisite mathematics course (R. K. Hart, 1999).

Finally, Croom (1997) stated that cooperative learning promotes minority students’ self-esteem, motivation, and achievement: and improves attitudes toward classmates, particularly those from different ethnic groups. Learning is improved when students interact in cooperative groups since “the brain is innately social and collaborative” (Wolfe & Brandt, 1998, p. 11).

Expressive Writing and Speaking

Without language, humans would be limited to elementary mental functions such as sensing and perceiving. However, with language, thinking is possible (Lefrancois, 2000). Expressive writing is a way of writing that encourages students to think on paper rather than communicate information or persuade an audience, as is usually the case with classroom writing. This approach is being used to facilitate the learning of undergraduate mathematics on a relatively small scale. To date, not much research has been done on the effect of writing in the undergraduate mathematics curriculum (Isom, 1996). However, research shows that this method does provide benefits to the learning of mathematics (Rose, 1989).

Similarly, articulation, a cognitive apprenticeship technique, encourages learners to verbalize their conclusions, descriptions, and principles they have discovered. This forces students to think more clearly (Collins, Brown, & Newman, 1989). One example of articulation is Mulcahy’s (1991) use of the Socratic dialogue, a series of questions and answers for thinking.
Another form of expressive writing is journal writing. It is an effective writing activity for learning mathematics. A journal is a type of personal writing where students have a chance to be introspective about themselves as learners and about the concepts, ideas, and principles of the materials they are learning (Brown, Phillips, & Stephens, 1993). It is very effective in communicating between students and teachers. Students are more inclined to write with candor about their feelings of anxieties or excitement about topics in mathematics and their learning experiences in and outside of classes. It also helps teachers to “better assess students’ responses to, and learning from, certain teaching strategies and activities in mathematics” (Chambers, 2000, p. 6).

The NCTM process standard on communication suggests that students are more likely to achieve greater mathematical understanding when they communicate the results of their thinking orally and in writing. In addition, Vygotsky’s theory of social/cognitive development, with its emphasis on the role of language in higher-level thinking, presents a strong argument for language-related activities in school for instruction and learning (Lefrancois, 2000).

However, while proponents of the use of expressive writing and speaking in mathematics highlights their benefits, opponents question the ability to measure their effects on the learning of mathematics (Connolly & Vilardi, 1989).

Calculator-Based Instruction

Waits and Demana (2000) noted that teachers must be competent in using tools such as electronic calculators as “power tools” to enhance student problem-solving. They stated that 81% of U. S. middle-school students had calculators, up from 21% in 1986. Calculators also play an important role in the business calculus curriculum at the
university level (Vest, 1991). For example, graphing and symbolic manipulation calculators are becoming more popular. The graphics calculator provides graphical information that is independent of students’ algebraically derived information. Where the two do not agree, the teacher gains a deeper insight into the students’ level of understanding (Boers & Jones, 1994).

In a 5-year study investigating students in a pre-calculus course for business and health professions majors at the University of Hartford, it was found that the use of graphing calculator and calculator-based laboratory improved students’ understanding of mathematical concepts (Haruta et al., 1998). Kasten et al. (1988) agreed by saying that computers and advanced calculators can now do many of the manipulations that students learned in calculus.

Computer Assisted Instruction (CAI)

CAI deals with the various ways in which the computer facilitates the teaching of calculus. Many mathematics programs are available, making the computer a very versatile tool for learning mathematics. For example, the University of Tennessee Knoxville produces advanced-level mathematics software that is available for public use (see: http://archives.math.utk.edu/). In addition, CAI has been used to facilitate the re-sequencing of skills and applications within an elementary college-level business calculus course (Judson, 1990). The results from this study confirmed earlier findings that conceptual understanding and problem-solving ability do not depend on prior mathematical skills acquisition.

The spreadsheet is also a useful mathematical tool. Its use in the business arena is critical. Its use results in mathematical procedures being more easily and more visually

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represented than in a programming language (Steward, 1994). Lastly, Clarke (2001) noted that many geometry programs allow students to explore concepts relating to distance, angles, areas, polygons, and circles. However, while it is important to prepare students to use technology in this knowledge-based technologically driven world, we have to be careful that it does not undermine certain mental processes that make human life worth living (Postman, 1993).

Hands-on Teaching

In response to the poor mathematics performance highlighted by the Nation at Risk (U.S. Department of Education, 1983), the NCTM suggested that teachers provide students with hands-on encounters with mathematical concepts along with other approaches to teaching mathematics. Learning is most effective when it impacts as many of the senses as possible, not just the visual and auditory, as is often the case in traditional classrooms, but also the psychomotor—a holistic approach to learning (Lopez & Alipon, 2001). The Chinese philosopher, Confucius, stated: "I hear and I forget, I see and I remember, I do and I understand" (as cited in Clarke, 2001, p. 39). Clarke noted that doing mathematics should incorporate the use of concrete objects, not just paper and pencil exercises.

The body should be involved with the mind in understanding and retaining mathematical concepts since multiple neural connections are formed in the brain through the use of all the senses. Spain’s Ministry of Education concurs with this approach by requiring its teachers to use ‘mathematical activity’ in the classrooms to construct mathematical thinking (Camacho, Socas, & Hernandez, 1998). Goad (2001) also agrees by noting that teaching that uses hands-on experiences is easier to master and creates
longer lasting memories. Finally, Professors for Rethinking Options in Mathematics for Prospective Teachers (PROMPT) have created many hands-on activities, which may be used to enhance the learning of mathematics (see: http://weasel.cnrs.humboldt.edu/~prompt/107/index.html).

History in Mathematics

Clarke (2001) noted the benefit of using history in teaching university-level mathematics. For example, he used the history of the development of the Hindu-Arabic number system to help students appreciate its usefulness in mathematics today. Furthermore, by helping students to see mathematicians as real people, with families, real life, and problems like themselves, it helps them to see mathematics as a normal human endeavor, rather than as a cold, impersonal course. He quoted Ubiratan D'Ambrósio of the Universidade Estadual de Campinas in Sao Paulo, Brazil, as saying that mathematics is "an integrating part of a culture, the same as language, arts, religions, and modes of explanations" (p. 42).

Individualized Instruction

Individualized instruction is an instructional procedure that is deliberately and systemically adapted to the students' needs, interests, learning styles, stages of development, and abilities. Students have a one-to-one relationship with their teachers and learn and master concepts at their own pace. This one-to-one interaction allows for more flexibility in teaching, and increases students' self-confidence and retention of concepts (Johnson, 1981; Koch, 1992; Maxwell, 1991).
Individualized instruction is appropriate since students are usually at different stages of development and have different abilities, intelligences (Gardner, 1983), and learning styles. It is also conducive to mastery learning which can be very good at improving students’ achievement, especially among low achievers (Kennedy, 1988). Studies have found that individualized instruction enhances mathematics performance (Cox, 1993; Slavin & Karweit, 1985). Studies have also showed that individualized instruction improves the attitudes of students who were apprehensive regarding mathematics due to years of failure (Aiken, 1976; Joyce & Weil, 1986).

Although individualized teaching is desirable, it might be difficult to implement since it requires a very high teacher-to-student ratio, which can be very costly.

**Summary of Literature Review**

This chapter addressed the problems of learning mathematics in the world in general and in Jamaica in particular. It considered variables necessary for success in Business Calculus 1. It also considered the rationale for the first course in business calculus and how it fits into the undergraduate business curriculum and implications for the quantitative skills of business graduates and economic growth. The varying standards for teaching mathematics, both in Jamaica and the United States, were presented along with innovative ways of teaching mathematics.

From the review of the literature the following implications exist. Quantitative skills are very important for functioning in this technologically advanced world (Cox, 1993; Thurow, 1987). Both universities and the job market are placing much emphasis on these skills (Clarke, 1979). Business Calculus 1 plays an important role in undergraduate business curricula of universities in that it helps to develop quantitative,
critical thinking, problem solving, creative thinking, reasoning, analytical, and presentation skills, which are required by the job market (Caissey, 1990; Joyce & Voytek, 1996; Levenburg, 1996; Van Horn, 1995). It also provides a quantitative foundation for upper-level courses such as economics, business and economic statistics, quantitative business analysis, production and operations management, and financial management (Kasten et al., 1988).

However while this is taking place, poor mathematics performance is a problem not just in Jamaica, but also in Eastern and Western countries (Malaty, 1998). This has economic implications since economic development depends to some extent on graduates with developed quantitative skills.

In many studies reviewed it was found that the following variables affected performance in Business Calculus 1 in particular and mathematics in general: mathematics background, practice, absence of mathematics anxiety, positive attitude towards calculus, thinking skills, problem solving skills, ability, relevance, cognitive factors, affective factors, and professor quality (Arismendi-Pardi, 1997; Cox, 1993; England, 2001; MacKay, 1982; Maysick, 1984; Norma & Rendon, 1990; U.S. Department of Education, 1997).

In response to the poor mathematics performance, standards have been developed to improve the teaching and learning of mathematics. Both in Jamaica and the United States standards have been developed in response to the following needs:

1. The need for a mathematically literate workforce
2. The need for citizens to be capable of interpreting quantitative information
3. The need for citizens to function in a rapidly changing world
The need to provide educational and professional opportunity for all students. These standards emphasized the following:

1. Problem-solving skills rather than rote learning
2. Thinking and reasoning skills in real life context
3. Creativity and enquiry
4. Investigating skills
5. Mathematics communication skills
6. Student-centered environment, which empowers students.

The literature suggests that in order to achieve the above objectives, the lecture method, which is the predominant teaching method in educational institutions (Cienkus & Ornstein, 1997; Goodlad, 1983), should be replaced with more constructivist approaches such as cooperative learning, expressive writing and speaking, calculator-based instruction, computer assisted instruction, hands-on teaching, history in mathematics, and individualized instruction. In addition, the literature reflected that these innovative methods have the following benefits: improved social skills, personal growth, improved interpersonal relationships, more self-confidence, more attention for students, reduced mathematics anxiety, and enhanced learning.
CHAPTER III

RESEARCH METHODOLOGY

Organization of Chapter

This chapter addresses the following topics. First, the type of research describes what the study sought to discover. Next, the method employed to collect data and carry out the research is presented. Third, the samples section outlines the sources and number of participants used. It looks at why and how the participants were selected. Then, the instrumentation section describes the measures used and how they measured the variables in the hypotheses and research questions. It also discusses validity, reliability, and the pilot study. Furthermore, it highlights how the instruments were pre-tested for content validity and reliability.

The variable section names and numerates the variables of the study. This is followed by a discussion of the data collection procedures, which itemizes the steps used to distribute and collect the questionnaires. The null hypotheses are then stated, followed by a description of the statistical tests used to test the research questions and hypotheses. Lastly, human subject considerations are addressed.

Type of Research

This study investigated the reasons why some university students do well at the first course in business calculus while others do not. To this end the study measured the perceptions of both students and their professors regarding the importance of selected
variables related to success in the first course in business calculus. The study also measured the perceptions of the students regarding the extent to which they perceived that they possess these variables.

**Design of the Study**

This study utilized a survey design method to find out from the students and their professors their perceptions of the factors that contribute to success in the first course in business calculus. The purpose of the design was to compare the responses of successful students with those of unsuccessful students regarding their perceptions of the importance of variables and the degree to which they possessed them. The business calculus professors’ perceptions were also measured.

The means of collecting data was surveys, since survey methodology is able to measure perceptions (Worthen, Sanders, & Fitzpatrick, 1997).

**Samples**

The primary subjects were business calculus students from three Jamaican universities. All subjects did Business Calculus 1 in the academic year 2000/2001. Two of these universities are public and the other is private. The private university had approximately 180 students in Business Calculus 1 in the academic year 2000/2001, while one of the public universities had approximately 400 and the other 300 students. One hundred thirty questionnaires were issued to the private university, 300 to the bigger public university, and 200 to the other public university. A total of 20 questionnaires were issued to the professors of the three universities.
Instrumentation

I modified survey instruments used by Williams (1998) to examine the research questions. This modification of the instrument was necessary because of the different context and primary focuses of the two studies. The instrument used to collect information from the students was divided into six sections. Section 1 solicited information on the variables students perceived to be important for success in the first course in business calculus. Section 2 sought information on the extent to which the students perceived they possessed these variables. Section 3 requested information on students' cognitive processes. Section 4 solicited information on students' affective factors. Section 5 looked at students' perceptions of professor effectiveness. Lastly, section 6 garnered information about students' gender, stage in their program (year), last educational institution attended, grade on first attempt at Business Calculus 1, grade on first attempt at CXC mathematics (general proficiency), father's education, mother's education, cumulative GPA, and program of study/major.

The instrument used to collect information from the professors had one section. It solicited information on the variables the professors perceive to be important for success in the first course in business calculus. The instrument for the students had 54 items, while the instrument for the professors had 10 items. The students took 20-25 minutes to complete their questionnaires.

This research was a self-reported study and so the results reflect the respondents' perceptions of reality. Consequently, caution should be exercised regarding generalization of the final results across other universities.
Validity and Reliability

The instruments were given to my dissertation committee members and other faculty members for expert reviews. These experts checked for internal consistency among the items. As a result of these consultations the definition of the variables in Section 1, of both the professor’s and student’s instruments, was stated more clearly to enhance understanding. In addition, items requiring the respondents to rank the variables were included in order to corroborate the results of the rating of the variables (see item 10, Section 1 of professor’s and student’s instruments. See also item 10, Section 2 of student’s instrument).

Furthermore, in order to enhance validity and reliability, some items were arranged in reversed order to help to ensure that respondents stayed alert while responding to the items (see Section 5 of student’s instrument). Efforts were also made to ensure standard data collection for each participant. The participants were given the same directions and the same length of time to answer questions.

Lastly, the instruments were pre-tested, using a similar group to the research group. The pre-test group provided feedback regarding appropriateness of the items and directions, and clarity of instruments. This feedback was used to revise the instruments.

Pilot Study

A pilot study was done in September 2001 involving 30 students from Northern Caribbean University. School of Business. The intention was to identify and correct any unclear items on the questionnaires. Adjustments were made based on feedback from the students. Four redundant items in Section 5 of the student’s instrument dealing with professor’s effectiveness were removed, thereby reducing the number of items in that
section from eleven to seven. From this pilot study, the time required for completing the instruments was also ascertained.

Furthermore, the pilot study highlighted the instrument’s ability to identify significant differences between successful and unsuccessful students. The following results were ascertained as a result of using the independent sample $t$ test to test differences between the two groups.

1. There was a significant difference regarding the importance of positive attitude between successful and unsuccessful students with $t = 2.261$ and $p = .032$. The successful and unsuccessful students had means of 4.50 and 3.92 respectively, and standard deviations of 0.62 and 0.79 respectively.

2. There was a significant difference regarding professor’s fairness between successful and unsuccessful students with $t = 2.664$ and $p = .017$. The successful and unsuccessful students had means of 4.67 and 3.50 respectively, and standard deviations of 0.77 and 1.38 respectively.

3. There was a significant difference regarding degree of fun between successful and unsuccessful students with $t = 2.168$ and $p = .046$. The successful and unsuccessful students had means of 6.00 and 4.92 respectively, and standard deviations of 0.91 and 1.56 respectively.

The pilot and main studies were consistent in reflecting that affective, more than cognitive and professor effectiveness variables, significantly differentiated between successful and successful students.

In addition, both students’ rating and ranking of the variables in the pilot study showed the five most important variables for success in Business Calculus 1 as
practice, positive attitude, mathematics background, thinking skills, and professor quality. 

These results were corroborated by the main study.

Variables

This study examined variables that relate to success in Business Calculus 1. For the $t$ tests, the two independent variables were successful/unsuccessful and professor student. The dependent variables were: (a) mathematics background, (b) practice, (c) absence of mathematics anxiety, (d) positive attitude towards calculus, (e) thinking skills, (f) problem solving skills, (g) ability, (h) relevance, (i) cognitive factors, (j) affective factors, and (k) professor quality.

For the discriminant analysis, in the terminology of the SPSS program, the grouping variables were professor/student, and successful/unsuccessful. The independent variables were: (a) mathematics background, (b) practice, (c) absence of mathematics anxiety, (d) positive attitude towards calculus, (e) thinking skills, (f) problem solving skills, (g) ability, (h) relevance, (i) cognitive factors, (j) affective factors, and (k) professor quality.

In addition the following demographic variables were used to describe the students: (a) sex, (b) major, (c) last educational institution attended, (d) year, (e) whether successful on first attempt at Business Calculus 1, (f) cumulative GPA, (g) CXC mathematics grade, (h) father’s education, and (i) mother’s education.

Data Collection Procedures

Letters were sent to the deans of the schools of business requesting their permission to conduct the study. The data was collected in the fall semester of the
academic year 2001-2002. Intact convenience samples of students were used. These intact samples were drawn from classes where Business Calculus 1 is not a pre-requisite. I visited the universities in order to have the instruments administered. This ensured that the instruments were administered under similar conditions for all three universities. Lastly, the instruments were distributed in a class setting and collected before the classes were dismissed.

**Null Hypotheses**

Eleven null hypotheses were used to answer the eight research questions of this study.

*Hypothesis 1:* There is no significant difference between the perceptions of students and their professors in the three universities regarding the degree of importance of the dependent variables to the successful completion of the first course in business calculus.

For this hypothesis the dependent variables were: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, and professor quality. This hypothesis was tested, once for each of the dependent variables. The $t$ test for independent samples was used.

*Hypothesis 2:* There is no linear combination of the independent variables regarding importance that significantly discriminates between Business Calculus 1 students and their professors in the three universities.

The independent variables here were the same as the dependent variables in hypothesis 1. This hypothesis was tested by discriminant analysis.
Hypothesis 3: There is no significant difference between the perceptions of successful and unsuccessful students in the three universities regarding the degree of importance of the dependent variables to the successful completion of the first course in business calculus.

The dependent variables here were the same as those in hypothesis 1. This hypothesis was tested, once for each of the dependent variables. The $t$ test for independent samples was used.

Hypothesis 4: There is no linear combination of the independent variables regarding importance that significantly discriminates between successful and unsuccessful Business Calculus I students in the three universities.

The independent variables here were the same as the dependent variables in hypothesis 1. This hypothesis was tested by discriminant analysis.

Hypothesis 5: There is no significant difference in the perceptions of successful and unsuccessful students in the three universities regarding their degree of possession of the dependent variables considered necessary for the successful completion of Business Calculus 1.

The dependent variables were the same as those in hypothesis 1. This hypothesis was tested, once for each of the dependent variables. The $t$ test for independent samples was used.

Hypothesis 6: There is no linear combination of the independent variables regarding possession that significantly discriminates between successful and unsuccessful Business Calculus 1 students.
The independent variables here were the same as the dependent variables in hypothesis 1. This hypothesis was tested by discriminant analysis.

*Hypothesis 7:* There is no linear combination of the cognitive variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

These cognitive variables were: out-of-class group work, out-of-class individual work, active class participation, clarification of unclear issues with professor, use of calculus 1 principles in everyday out-of-class activities, analysis of calculus 1 principles and concepts, exploring new ways of solving problems, consistent out-of-class study routine, and revision of principles immediately after they are taught. This hypothesis was tested by discriminant analysis.

*Hypothesis 8:* There is no linear combination of the affective variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

These affective variables were: professor’s help, relationship with other business calculus students, degree of comfort in business calculus class, fairness of business calculus professor, respectfulness of business calculus professor, and feeling of comfort at university. This hypothesis was tested by discriminant analysis.

*Hypothesis 9:* There is no linear combination of the perceptions of professors’ effectiveness variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

These professor effectiveness variables were degree of: clarity, motivation, excellence, fun, encouragement, availability, and supportiveness. This hypothesis was
tested by discriminant analysis.

*Hypothesis 10:* There is no linear combination of all the variables (in hypotheses 1-9) that significantly discriminates between successful and unsuccessful Business Calculus 1 students in the three universities.

This hypothesis was tested by discriminant analysis.

*Hypothesis 11:* There is no change of attitude after doing Business Calculus 1?

Cross tabulation and chi-square were used to test this hypothesis.

All the above hypotheses were tested at the 5% alpha level (\( \alpha = .05 \)).

**Analysis of Data**

Descriptive statistics, cross tabulation, chi-square, discriminant analysis, and the \( t \) test of two independent means were used to analyze the data. The \( t \) test was selected because it is useful in comparing the size of between-group differences with the size of within-group differences due to individual variability (Rudestam & Newton, 2001). More specifically, the independent samples \( t \) test was used because the samples used had different subjects in each group, even though they were drawn from the same population (McMillan & Schumacher, 1997). The \( t \) test of two independent means was used effectively to analyze group differences in a study that examined perceptions of a population similar to the one in this study (Williams, 1998).

Discriminant analysis was used to look at the overall effect of the independent variables on the dependent variable and take into account the interrelationships among the independent variables. The stepwise method was used which involves the use of Wilks’s lambda and \( F \) statistic ratio to add and remove variables from the analysis until the variables which best differentiate between the two groups are selected. The
effectiveness of discriminant analysis was checked by looking at the percentage of cases correctly classified.

Cross tabulation and chi-square were used to examine the relationship and significance of the relationship, respectively, between variables.

For interpretation of the results of research question 1, the 5-point scale regarding importance of variables was rated as follows: 1.00-2.75, little importance; 2.76-3.75, some importance; and 3.76-5.00, much importance (Williams, 1998).

**Human Subject Considerations**

Care was taken to be ethical and to protect the rights of everyone affected by this research. The completion of the surveys and other instruments was totally voluntary and respondents had the option to quit at any time. Anonymity and confidentiality were ensured at all times by coding the instruments. The recommendation of The Joint Committee on Standards for Educational Evaluation (1994) regarding recognition and protection of the rights of individuals was followed. It states: “Evaluators should respect human dignity and worth in their interactions with other persons associated with an evaluation, so that participants are not threatened or harmed” (p.99).

**Summary**

The study measured the perceptions of Jamaican university Business Calculus 1 students and their professors regarding the importance of variables for success in Business Calculus 1 using a survey design. Data was collected using two survey instruments. The study used discriminant analysis, cross tabulation, chi-square, and $t$ test to examine differences between students and their professors and also differences...
between successful and unsuccessful students regarding variables for success in Business Calculus 1. The participants consisted of 389 Business Calculus 1 students and 12 of their professors drawn from three Jamaican universities.

The instrument for the students had six sections and 54 items covering affective, cognitive, professor effectiveness, and demographics variables, while the professors' instrument had one section and 10 items covering affective, cognitive, and professor effectiveness variables. The instruments were pilot tested by sampling 30 Northern Caribbean University Students. Data was collected during the fall semester 2001 from intact undergraduate business classes. Finally, eleven hypotheses were tested in this study.
CHAPTER IV

ANALYSIS OF DATA

This chapter has three sections. First, a descriptive analysis of the data is presented. Second, the findings from the research questions and hypotheses are given. Lastly, a summary of the chapter is presented.

The purpose of this study was to investigate the factors related to the successful completion of the first course in business calculus at Jamaican universities. To satisfy this objective, the study examined the perceptions of students and their professors to ascertain the variables they considered important for success and the degree to which the students possessed these variables.

Descriptive Analysis of the Population

Data was collected from the following institutions. Institution A is a private liberal arts university in central Jamaica with student enrollment of approximately 3,500 at the time of this study. It was founded in 1919 as a college and acquired university status in 1999. It offers both undergraduate and graduate degrees in the arts, sciences, and business areas. The University Council of Jamaica accredits most of its degrees.

Institution B is public university in Kingston with student enrollment of approximately 8,000 at the time of this study. It was founded in 1958 as a technical-vocational college and attained university status in 1996. It grants both
undergraduate and graduate degrees in many vocational areas, and the University Council of Jamaica accredits most of its programs.

Lastly, institution C is also a public university in Kingston with approximately 10,000 students enrolled at the time of this study. It was founded in 1948 as an affiliated campus of a British university. It later gained full autonomy as a degree-granting university serving the Caribbean region. It offers undergraduate and graduate degrees in the arts, sciences, and business fields, and the University Council of Jamaica accredits most of its programs.

A total of 650 students and faculty from the three universities were given questionnaires. Table 1 shows the invited and responding student samples by university.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SAMPLE OF STUDENTS BY UNIVERSITIES</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Universities</th>
<th>No. of Students Sampled</th>
<th>No. of Usable Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>130</td>
<td>91</td>
</tr>
<tr>
<td>B</td>
<td>200</td>
<td>142</td>
</tr>
<tr>
<td>C</td>
<td>300</td>
<td>156</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>630</strong></td>
<td><strong>389</strong></td>
</tr>
</tbody>
</table>

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A total of 630 questionnaires were distributed to students who did business calculus in 2000/2001, of which 389 usable ones were collected, resulting in a return rate of 61.7%. Table 2 shows that 20 questionnaires were distributed to professors, of which 12 usable ones were returned, resulting in a return rate of 60.0%. One hundred and two students responded to the open-ended questions, while eight professors responded.

### TABLE 2

**SAMPLE OF FACULTY BY UNIVERSITIES**

<table>
<thead>
<tr>
<th>Universities</th>
<th>No. of Professors Sampled</th>
<th>No. of Usable Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

The demographic information from the 389 students reflected the following. Table 3 gives an analysis of the students based on their majors. It showed: accounting 35.7%; management 34.4%; marketing 10.0%; finance 6.9%; and other 12.9%. It also showed that of the 389 students sampled, 31.1% were males while 68.9% were females.

Table 4 shows students by academic year when they did Business Calculus 1. The majority (83.5%) of the students did Business Calculus 1 in year one, as prescribed by the bulletin. It also shows the most critical demographic variable: Business Calculus 1 grade on first attempt. The essence of this study was to examine which factors result in
TABLE 3

STUDENTS BY MAJOR (Percentages in Parentheses)

<table>
<thead>
<tr>
<th>Major</th>
<th>Gender</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Accounting</td>
<td>45 (37.2)</td>
<td>94 (35.1)</td>
</tr>
<tr>
<td>Management</td>
<td>42 (34.7)</td>
<td>92 (34.3)</td>
</tr>
<tr>
<td>Marketing</td>
<td>13 (10.8)</td>
<td>26 (9.7)</td>
</tr>
<tr>
<td>Finance</td>
<td>12 (9.9)</td>
<td>15 (5.6)</td>
</tr>
<tr>
<td>Other</td>
<td>9 (7.4)</td>
<td>41 (15.3)</td>
</tr>
<tr>
<td>Total</td>
<td>121 (31.1)</td>
<td>268 (68.9)</td>
</tr>
</tbody>
</table>

Note. "Other" includes human resource management, computer science, and business education.

TABLE 4

STUDENTS BY ACADEMIC YEAR (Percentages in Parentheses)

<table>
<thead>
<tr>
<th>Year</th>
<th>Business Calculus 1 Results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>Freshman</td>
<td>235 (86.4)</td>
<td>90 (77.0)</td>
</tr>
<tr>
<td>Sophomore</td>
<td>26 (9.6)</td>
<td>14 (12.0)</td>
</tr>
<tr>
<td>Junior</td>
<td>9 (3.3)</td>
<td>8 (6.8)</td>
</tr>
<tr>
<td>Senior</td>
<td>2 (0.7)</td>
<td>5 (4.2)</td>
</tr>
<tr>
<td>Total</td>
<td>272 (69.9)</td>
<td>117 (30.1)</td>
</tr>
</tbody>
</table>

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a difference in students' performance in Business Calculus 1. The sample revealed that 69.9% of the students were successful when they attempted Business Calculus 1 for the first time, whereas 30.1% were unsuccessful. Table 5 shows students by previous academic institution.

Table 5 shows that most of the students attended high school just before enrolling at their universities. The actual percentages were as follows: high school 67.6%,
secondary 2.1%, technical high 2.4%, comprehensive high 2.1%, teacher's college 1.6%, college 21.5%, and university 2.7%. In addition, Table 5 shows students’ performance in the CXC mathematics examinations. Eighty-one percent (81.1%) of them were successful on their first attempt, while 18.9 were unsuccessful.

Table 6 shows the analysis of the cumulative (4-point) grade point average (GPA) of the students sampled.

<table>
<thead>
<tr>
<th>GPA</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2.50</td>
<td>19</td>
<td>8.0</td>
</tr>
<tr>
<td>2.50 to 3.49</td>
<td>185</td>
<td>77.7</td>
</tr>
<tr>
<td>3.50 to 3.74</td>
<td>23</td>
<td>9.7</td>
</tr>
<tr>
<td>3.75 to 3.89</td>
<td>4</td>
<td>1.7</td>
</tr>
<tr>
<td>3.90 to 4.00</td>
<td>7</td>
<td>2.9</td>
</tr>
<tr>
<td>Total</td>
<td>238</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Of the 238 students who responded to this item, 8.0% had below average GPA (< 2.50), 77.7% average (2.50 to 3.49), 9.7% cum laude (3.50 to 3.74), 1.7% magna cum laude (3.75 to 3.89), and 2.9% summa cum laude (3.90 to 4.00). Finally, since one’s
family background is believed to influence one’s performance. I asked for the parents’ level of education. Table 7 shows students’ fathers’ highest level of education.

### TABLE 7

**FATHERS’ HIGHEST LEVEL OF EDUCATION**

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>70</td>
<td>19.3%</td>
</tr>
<tr>
<td>Secondary</td>
<td>210</td>
<td>58.0%</td>
</tr>
<tr>
<td>First Degree</td>
<td>55</td>
<td>15.2%</td>
</tr>
<tr>
<td>Master’s Degree</td>
<td>23</td>
<td>6.4%</td>
</tr>
<tr>
<td>Doctoral</td>
<td>4</td>
<td>1.1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>362</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Of the 362 students who responded to this item regarding father’s education; 19.3% said primary, 58.0% secondary, 15.2% first degree, 6.4% master’s degree, and 1.1% doctoral.

Table 8 shows students’ mothers’ highest level of education. Of the 365 students who responded, 14.2% said primary, 61.9% secondary, 18.1% first degree, 4.9% master’s degree, and 0.8% doctoral.
TABLE 8
MOTHERS' HIGHEST LEVEL OF EDUCATION

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>52</td>
<td>14.2</td>
</tr>
<tr>
<td>Secondary</td>
<td>226</td>
<td>61.9</td>
</tr>
<tr>
<td>First Degree</td>
<td>66</td>
<td>18.1</td>
</tr>
<tr>
<td>Master's Degree</td>
<td>18</td>
<td>4.9</td>
</tr>
<tr>
<td>Doctoral</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Total</td>
<td>365</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Rating and Ranking of the Variables

The students and professors used a 5-point Likert scale to rate each of the variables according to the level of importance for success (in Business Calculus 1) that they ascribed to them.

In order to interpret the responses, the 5-point Likert scale regarding importance of variables was reduced to three categories and rated as follows: 1.00-2.75, little importance; 2.76-3.75, some importance; and 3.76-5.00, much importance. These criteria used by the researcher should not be considered as absolute measures of the respondents' intentions; they are primarily for understanding the responses.
Table 9 shows the students’ ratings of the variables in terms of importance.

TABLE 9
STUDENTS’ PERCEPTIONS (RATING) OF IMPORTANCE OF VARIABLES
FOR SUCCESS IN BUSINESS CALCULUS I (N=389)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>4.37^</td>
<td>0.86</td>
<td>1</td>
</tr>
<tr>
<td>Professor Quality</td>
<td>4.31^</td>
<td>1.03</td>
<td>2</td>
</tr>
<tr>
<td>Mathematics Background</td>
<td>4.27^</td>
<td>0.98</td>
<td>3</td>
</tr>
<tr>
<td>Problem Solving Skills</td>
<td>4.14^</td>
<td>0.90</td>
<td>4</td>
</tr>
<tr>
<td>Positive Attitude</td>
<td>4.12^</td>
<td>1.00</td>
<td>5</td>
</tr>
<tr>
<td>Thinking Skills</td>
<td>3.98^</td>
<td>0.95</td>
<td>6</td>
</tr>
<tr>
<td>No Anxiety</td>
<td>3.88^</td>
<td>1.05</td>
<td>7</td>
</tr>
<tr>
<td>Relevance</td>
<td>3.28</td>
<td>1.21</td>
<td>8</td>
</tr>
<tr>
<td>Ability</td>
<td>3.15</td>
<td>1.13</td>
<td>9</td>
</tr>
</tbody>
</table>

^Satisfies criteria for Much Importance.

The students perceived that all the variables except ability and relevance were of much importance. They perceived that ability and relevance were of some importance. The variables, in order of perceived importance of the students, were ranked as follows: first, practice, with mean of 4.37; second, professor quality, with mean of 4.31; third, mathematics background, with mean of 4.27; fourth, problem-solving skills, with mean of 4.14; fifth, positive attitude, with mean of 4.12; sixth, thinking skills, with mean of
3.98; seventh, no anxiety, with mean of 3.88; eighth, relevance, with mean of 3.28; and ninth, ability, with mean of 3.15.

The students' responses regarding the most and next most important variables (see item 10, section 1, of Student's Questionnaire) for success in Business Calculus 1 were combined and the percentage of students selecting each variable ascertained. Table 10 shows the students' ranking of the variables in terms of importance.

TABLE 10

STUDENTS' PERCEPTIONS (RANKING) OF MOST IMPORTANT VARIABLE FOR BUSINESS CALCULUS 1 SUCCESS

<table>
<thead>
<tr>
<th>Variables</th>
<th>Percentage</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>27.38</td>
<td>1</td>
</tr>
<tr>
<td>Professor Quality</td>
<td>18.39</td>
<td>2</td>
</tr>
<tr>
<td>Positive Attitude</td>
<td>18.25</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics Background</td>
<td>9.52</td>
<td>4</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>9.38</td>
<td>5</td>
</tr>
<tr>
<td>Thinking Skills</td>
<td>8.35</td>
<td>6</td>
</tr>
<tr>
<td>No Anxiety</td>
<td>3.98</td>
<td>7</td>
</tr>
<tr>
<td>Ability</td>
<td>2.44</td>
<td>8</td>
</tr>
<tr>
<td>Relevance</td>
<td>2.31</td>
<td>9</td>
</tr>
</tbody>
</table>
The results show that 27.38% of the students ranked practice as most important, 18.39% ranked professor quality first, 18.25% ranked positive attitude first, 9.52% ranked background first, 9.38% ranked problem-solving first, 8.35% ranked thinking skills first, 3.98% ranked no anxiety first, 2.44% ranked ability first, and 2.31% ranked relevance first. A comparison of the rating and ranking of the variables by the students shows practice, professor quality, and mathematics background among the top four positions. A similar comparison shows relevance, ability, and no anxiety as the bottom three variables.

Table 11 shows the professors' rating of the variables in terms of importance. The professors perceived that all the variables except ability were of much importance. Ability was considered to be of some importance by them. The variables, in order of perceived importance of the professors, were ranked as follows: first, problem-solving skills, with mean of 4.58; second, practice, with mean of 4.42; third, thinking skills, with mean of 4.33; fourth, professor quality, with mean of 4.25; fifth, positive attitude, with mean of 4.25; sixth, mathematics background, with mean of 4.25; seventh, no anxiety, with mean of 4.08; eighth, relevance, with mean of 4.00, and ninth, ability, with mean of 3.50.

The professors' responses regarding the most and next most important variables (see item 10, section 1, of Faculty's Questionnaire) for success in Business Calculus 1 were combined and the percentage of professors selecting each variable ascertained.

Table 12 shows the professors' ranking of the variables in terms of importance. The results show that 20.83% of the professors ranked thinking skills as most important, 16.67% ranked practice first, 16.67% ranked problem-solving skills first, 16.67% ranked
### TABLE 11

**PROFESSORS' PERCEPTIONS (RATING) OF IMPORTANCE OF VARIABLES FOR SUCCESS IN BUSINESS CALCULUS I (N=12)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving Skills</td>
<td>4.58</td>
<td>0.79</td>
<td>1</td>
</tr>
<tr>
<td>Practice</td>
<td>4.42</td>
<td>0.90</td>
<td>2</td>
</tr>
<tr>
<td>Thinking Skills</td>
<td>4.33</td>
<td>0.65</td>
<td>3</td>
</tr>
<tr>
<td>Professor Quality</td>
<td>4.25</td>
<td>0.75</td>
<td>4</td>
</tr>
<tr>
<td>Positive Attitude</td>
<td>4.25</td>
<td>0.87</td>
<td>5</td>
</tr>
<tr>
<td>Mathematics Background</td>
<td>4.25</td>
<td>0.97</td>
<td>6</td>
</tr>
<tr>
<td>No Anxiety</td>
<td>4.08</td>
<td>0.79</td>
<td>7</td>
</tr>
<tr>
<td>Relevance</td>
<td>4.00</td>
<td>0.74</td>
<td>8</td>
</tr>
<tr>
<td>Ability</td>
<td>3.50</td>
<td>1.00</td>
<td>9</td>
</tr>
</tbody>
</table>

^Satisfies criteria for Much Importance.

mathematics background first, 12.50% ranked positive attitude first, 8.33% ranked professor quality first, 8.33% ranked no anxiety first, 0% ranked ability first, and 0% ranked relevance first. A comparison of the rating and ranking of the variables by the professors shows problem-solving, practice, and thinking skills in the top three positions.

A similar comparison shows relevance, ability, and no anxiety as the bottom three variables.
TABLE 12
PROFESSORS’ PERCEPTIONS (RANKING) OF MOST IMPORTANT VARIABLE FOR BUSINESS CALCULUS 1 SUCCESS

<table>
<thead>
<tr>
<th>Variables</th>
<th>Percentage</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking Skills</td>
<td>20.83</td>
<td>1</td>
</tr>
<tr>
<td>Practice</td>
<td>16.67</td>
<td>2</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>16.67</td>
<td>2</td>
</tr>
<tr>
<td>Mathematics Background</td>
<td>16.67</td>
<td>2</td>
</tr>
<tr>
<td>Positive Attitude</td>
<td>12.50</td>
<td>3</td>
</tr>
<tr>
<td>Professor Quality</td>
<td>8.33</td>
<td>4</td>
</tr>
<tr>
<td>No Anxiety</td>
<td>8.33</td>
<td>4</td>
</tr>
<tr>
<td>Relevance</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Ability</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Responses to Open-Ended Question

An analysis of the responses given by students to the open-ended question reflected the following as important for success: being open-minded, need for tutorials, more practice, more time needed in semester, understanding and caring lecturers who do not assume prior knowledge of calculus, availability of textbook, better mathematics background, competent teachers, family support, smaller class size, more access to professors, more practical and relevant teaching examples, and self-motivation. In
response to the open-ended question, the professors noted the following as important for
success: good texts, high expectations of professors, background knowledge, use of
computer software, proper classroom environment, cooperative group work, and effective
teaching.

Testing the Null Hypotheses

Eleven null hypotheses were stated in chapter 3. The results of these tests are
given below.

Null Hypothesis 1

Null hypothesis 1 states: There is no significant difference between the
perceptions of students and their professors in the three universities regarding the degree
of importance of the dependent variables to the successful completion of the first course
in business calculus.

For this hypothesis the dependent variables were: mathematics background,
practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-
solving skills, ability, relevance, and professor quality. This hypothesis was tested, once
for each of the dependent variables. The $t$ test for independent samples was used.

The Levene's test for equality of variances was used to determine which
independent sample $t$ test to use in the analysis. The pooled-variance $t$ test was used
where the group variances were equal, while the separate-variance $t$ test was used where
the group variances were not equal. Table 13 gives, for each variable, the results of the
Levene's test, and the results of the $t$ test.
TABLE 13

TEST OF SIGNIFICANCE OF DIFFERENCES BETWEEN THE MEANS OF BUSINESS CALCULUS I STUDENTS AND THEIR PROFESSORS IN JAMAICAN UNIVERSITIES REGARDING PERCEIVED IMPORTANCE OF VARIABLES FOR CALCULUS I SUCCESS

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>F</th>
<th>Sig.</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics Background</td>
<td>Professor</td>
<td>0.11</td>
<td>.739*</td>
<td>4.25</td>
<td>0.97</td>
<td>399</td>
<td>-0.078</td>
<td>.937</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>4.27</td>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Practice</td>
<td>Professor</td>
<td>0.041</td>
<td>.839*</td>
<td>4.42</td>
<td>0.90</td>
<td>399</td>
<td>0.174</td>
<td>.862</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>4.37</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. No Anxiety</td>
<td>Professor</td>
<td>1.175</td>
<td>.279*</td>
<td>4.08</td>
<td>0.79</td>
<td>399</td>
<td>0.676</td>
<td>.500</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>3.88</td>
<td>1.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Positive Attitude</td>
<td>Professor</td>
<td>0.027</td>
<td>.868*</td>
<td>4.25</td>
<td>0.87</td>
<td>399</td>
<td>0.453</td>
<td>.651</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>4.12</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Thinking Skills</td>
<td>Professor</td>
<td>0.937</td>
<td>.334*</td>
<td>4.33</td>
<td>0.65</td>
<td>399</td>
<td>1.274</td>
<td>.203</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>3.98</td>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Problem-Solving Skills</td>
<td>Professor</td>
<td>0.485</td>
<td>.487*</td>
<td>4.58</td>
<td>0.79</td>
<td>399</td>
<td>1.691</td>
<td>.092</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>4.14</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Ability</td>
<td>Professor</td>
<td>0.057</td>
<td>.812*</td>
<td>3.50</td>
<td>1.00</td>
<td>399</td>
<td>1.063</td>
<td>.289</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>3.15</td>
<td>1.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Relevance</td>
<td>Professor</td>
<td>6.083</td>
<td>.014#</td>
<td>4.00</td>
<td>0.74</td>
<td>12.89</td>
<td>3.233</td>
<td>.042*</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>3.28</td>
<td>1.21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Professor Quality</td>
<td>Professor</td>
<td>1.302</td>
<td>.255*</td>
<td>4.25</td>
<td>0.75</td>
<td>399</td>
<td>-0.195</td>
<td>.846</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td></td>
<td></td>
<td>4.31</td>
<td>1.03</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: For professor, *n = 12*; for student, *n = 389*.
^ Pooled (equal-variance t test; # Separate-variance t test.
*Significant at the 0.05 level (Reject H0).
Of the nine variables only one showed a significant difference between the professors' and students' means. Professors and students in the three Jamaican universities differed on the importance of relevance with $t = 3.223, p = 0.042$, professors' standard deviation of 0.74, and students' standard deviation of 1.21. Therefore the professors' mean of 4.00 was significantly greater than the students' mean of 3.28 and so the null hypothesis was rejected. However, the null hypothesis was retained for all the other variables.

Null Hypothesis 2

Null hypothesis 2 states: There is no linear combination of the independent variables regarding importance that significantly discriminates between Business Calculus 1 students and their professors in the three universities.

For this hypothesis the independent variables were: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, and professor quality. This hypothesis was tested by discriminant analysis.

Discriminant analysis using the stepwise variable selection method was used to ascertain the variable(s) considered important that discriminated between students and professors. The smallest Wilks's lambda and the $F$ statistics were used to select variables for entry and removal from the model. In addition, the model was tested for its effectiveness in variable selection by examining the number of cases classified correctly. Table 14 shows that one of the nine variables entered was included in the discriminant function.
<table>
<thead>
<tr>
<th>Rank</th>
<th>Variable</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Importance of Relevance</td>
<td>0.835</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-2.758</td>
<td></td>
</tr>
</tbody>
</table>

Group Means (Centroids) for Discriminant Functions

<table>
<thead>
<tr>
<th>Group</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>0.581</td>
</tr>
<tr>
<td>Students</td>
<td>-0.018</td>
</tr>
</tbody>
</table>

Wilks’s Lambda

<table>
<thead>
<tr>
<th>Wilks’s Lambda</th>
<th>Canonical Correlation</th>
<th>Chi-square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.990</td>
<td>0.102</td>
<td>4.144</td>
<td>1</td>
<td>.042</td>
</tr>
</tbody>
</table>

Classification Results

<table>
<thead>
<tr>
<th>Groups</th>
<th>Actual No. of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Professor</td>
<td>Students</td>
</tr>
<tr>
<td>Professor</td>
<td>12</td>
<td>9 (75.0%)</td>
</tr>
<tr>
<td>Students</td>
<td>389</td>
<td>176 (45.2%)</td>
</tr>
</tbody>
</table>

Note. 55.4% of cases correctly classified.
The variable was importance of relevance. The level of significance was 0.042. Therefore the null hypothesis was rejected. The classification table indicated that 55.4% of the subjects were correctly classified. The discriminant function suggests that professors tend to see relevance as being more important than do students.

Null Hypothesis 3

Null hypothesis 3 states: There is no significant difference between the perceptions of successful and unsuccessful students in the three universities regarding the degree of importance of the dependent variables to the successful completion of the first course in business calculus.

For this hypothesis the dependent variables were: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, and professor quality. This hypothesis was tested, once for each of the dependent variables. The \( t \) test for independent samples was used.

The Levene's test for equality of variances was used to determine which independent sample \( t \) test to use in the analysis. The pooled-variance \( t \) test was used where the group variances were equal, while the separate-variance \( t \) test was used where the group variances were not equal. Table 15 gives, for each variable, the results of the Levene’s test, and the results of the \( t \) test. Of the nine variables only one showed a significant difference between the successful and unsuccessful students’ means.

Successful and unsuccessful students in the three Jamaican universities differed on the importance of no anxiety with \( t = 2.068, p = 0.039 \), successful students’ standard deviation of 1.04, and unsuccessful students’ standard deviation of 1.06. Therefore the successful students’ mean of 3.95 was significantly greater than the unsuccessful
TABLE 15
TEST OF SIGNIFICANCE OF DIFFERENCES BETWEEN THE MEANS OF SUCCESSFUL AND UNSUCCESSFUL BUSINESS CALCULUS I STUDENTS IN JAMAICAN UNIVERSITIES REGARDING PERCEIVED IMPORTANCE OF VARIABLES FOR CALCULUS I SUCCESS

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>$F$</th>
<th>Sig.</th>
<th>Mean</th>
<th>$SD$</th>
<th>$df$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics</td>
<td>Pass</td>
<td>0.686</td>
<td>.408*</td>
<td>4.31</td>
<td>0.97</td>
<td>387</td>
<td>1.004</td>
<td>.316</td>
</tr>
<tr>
<td>Background</td>
<td>Fail</td>
<td></td>
<td></td>
<td>4.20</td>
<td>0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Practice</td>
<td>Pass</td>
<td>0.026</td>
<td>.873*</td>
<td>4.37</td>
<td>0.86</td>
<td>387</td>
<td>-0.178</td>
<td>.859</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>4.38</td>
<td>0.87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. No Anxiety</td>
<td>Pass</td>
<td>0.276</td>
<td>.600*</td>
<td>3.95</td>
<td>1.04</td>
<td>387</td>
<td>2.068</td>
<td>.039*</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.71</td>
<td>1.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Positive Attitude</td>
<td>Pass</td>
<td>0.186</td>
<td>.667*</td>
<td>4.17</td>
<td>0.95</td>
<td>387</td>
<td>1.427</td>
<td>.154</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>4.01</td>
<td>1.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Thinking Skills</td>
<td>Pass</td>
<td>3.674</td>
<td>.056*</td>
<td>3.99</td>
<td>0.99</td>
<td>387</td>
<td>0.416</td>
<td>.678</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.95</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Problem-Solving</td>
<td>Pass</td>
<td>0.772</td>
<td>.380*</td>
<td>4.19</td>
<td>0.89</td>
<td>387</td>
<td>1.707</td>
<td>.089</td>
</tr>
<tr>
<td>Skills</td>
<td>Fail</td>
<td></td>
<td></td>
<td>4.02</td>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Ability</td>
<td>Pass</td>
<td>0.034</td>
<td>.853*</td>
<td>3.20</td>
<td>1.11</td>
<td>387</td>
<td>1.415</td>
<td>.158</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.03</td>
<td>1.16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Relevance</td>
<td>Pass</td>
<td>6.650</td>
<td>.010#</td>
<td>3.03</td>
<td>1.25</td>
<td>248.61</td>
<td>1.358</td>
<td>.176</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.16</td>
<td>1.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Professor</td>
<td>Pass</td>
<td>1.535</td>
<td>.216*</td>
<td>4.33</td>
<td>1.06</td>
<td>387</td>
<td>0.545</td>
<td>.586</td>
</tr>
<tr>
<td>Quality</td>
<td>Fail</td>
<td></td>
<td></td>
<td>4.26</td>
<td>0.97</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: For pass, $n = 272$; for fail, $n = 117$.
* Pooled (equal)-variance $t$ test; # Separate-variance $t$ test.
* Significant at the 0.05 level (Reject $H_0$).
students’ mean of 3.71 and so the null hypothesis was rejected. However, the null hypothesis was retained for all the other variables. For these eight variables the means (on a scale of 1 to 5) for successful and unsuccessful students ranged from 3.20 to 4.37 and 3.03 to 4.38 respectively. The means for the successful students were generally higher than those of the unsuccessful students.

Null Hypothesis 4

Null hypothesis 4 states: There is no linear combination of the independent variables regarding importance that significantly discriminates between successful and unsuccessful Business Calculus 1 students in the three universities.

For this hypothesis the independent variables were: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, and professor quality. This hypothesis was tested by discriminant analysis.

Discriminant analysis using the stepwise variable selection method was used to ascertain the variable(s) considered important, that discriminated between successful and unsuccessful students. The smallest Wilks’s lambda and the $F$ statistics were used to select variables for entry and removal from the model. In addition, the model was tested for its effectiveness in variable selection by examining the number of cases classified correctly.

Table 16 shows that the importance of no anxiety was the only variable included in the discriminant function of the nine variables that were entered. The level of significance was 0.039. Therefore the null hypothesis was rejected. The classification table indicated that 60.2% of the students were correctly classified. The discriminant
TABLE 16

CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS REGARDING IMPORTANCE OF VARIABLES THAT DISCRIMINATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL STUDENTS USING WILKS’S LAMBDA

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variable</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Importance of no Anxiety</td>
<td>0.956</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-3.706</td>
<td></td>
</tr>
</tbody>
</table>

Group Means (Centroids) for Discriminant Functions

<table>
<thead>
<tr>
<th>Group</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Students</td>
<td>0.069</td>
</tr>
<tr>
<td>Unsuccessful Students</td>
<td>-0.160</td>
</tr>
</tbody>
</table>

Wilks’s Lambda

<table>
<thead>
<tr>
<th>Wilks’ Lambda</th>
<th>Canonical Correlation</th>
<th>Chi-square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.989</td>
<td>0.105</td>
<td>4.247</td>
<td>1</td>
<td>.039</td>
</tr>
</tbody>
</table>

Classification Results (Students)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Actual No. of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Successful</td>
<td>272</td>
<td>193 (71.0%)</td>
</tr>
<tr>
<td>Unsuccessful</td>
<td>117</td>
<td>76 (65.0%)</td>
</tr>
</tbody>
</table>

Note. 60.2% of cases correctly classified.
function suggests that students who recognize the importance of an anxiety-free mathematics learning experience are more likely to be successful than unsuccessful in Business Calculus 1.

Null Hypothesis 5

Null hypothesis 5 states: There is no significant difference in the perceptions of successful and unsuccessful students in the three universities regarding their degree of possession of the dependent variables considered necessary for the successful completion of Business Calculus 1.

For this hypothesis the dependent variables were: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, and professor quality. This hypothesis was tested, once for each of the dependent variables. The $t$ test for independent samples was used.

The Levene's test for equality of variances was used to determine which independent sample $t$ test to use in the analysis. The pooled-variance $t$ test was used where the group variances were equal, while the separate-variance $t$ test was used where the group variances were not equal. Table 17 gives, for each variable, the results of the Levene’s test, and the results of the $t$ test.

Of the nine variables only one showed a significant difference between successful and unsuccessful students. Successful and unsuccessful students in the three Jamaican universities differed on the possession of practice with $t = 2.263, p = 0.024$, successful students’ standard deviation of 0.95, and unsuccessful students’ standard deviation of 1.03. Therefore the successful students’ mean of 3.45 was significantly greater than the unsuccessful students’ mean of 3.21 and so the null hypothesis was rejected.

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TABLE 17

TEST OF SIGNIFICANCE OF DIFFERENCES BETWEEN THE MEANS OF SUCCESSFUL AND UNSUCCESSFUL BUSINESS CALCULUS I STUDENTS IN JAMAICAN UNIVERSITIES REGARDING THEIR PERCEIVED POSSESSION OF VARIABLES FOR CALCULUS I SUCCESS

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>( F )</th>
<th>Sig.</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>( t )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics</td>
<td>Pass</td>
<td>1.253</td>
<td>.264*</td>
<td>3.53</td>
<td>0.94</td>
<td>387</td>
<td>1.952</td>
<td>.052</td>
</tr>
<tr>
<td>Background</td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.32</td>
<td>0.91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Practice</td>
<td>Pass</td>
<td>0.140</td>
<td>.708*</td>
<td>3.45</td>
<td>0.95</td>
<td>387</td>
<td>2.263</td>
<td>.024*</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.21</td>
<td>1.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. No Anxiety</td>
<td>Pass</td>
<td>0.341</td>
<td>.559*</td>
<td>3.26</td>
<td>1.10</td>
<td>387</td>
<td>-0.315</td>
<td>.753</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.30</td>
<td>1.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Positive Attitude</td>
<td>Pass</td>
<td>0.586</td>
<td>.444*</td>
<td>3.64</td>
<td>1.13</td>
<td>387</td>
<td>1.095</td>
<td>.274</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.50</td>
<td>1.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Thinking Skills</td>
<td>Pass</td>
<td>0.961</td>
<td>.328*</td>
<td>3.50</td>
<td>0.92</td>
<td>387</td>
<td>1.152</td>
<td>.250</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.38</td>
<td>0.88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Problem-Solving</td>
<td>Pass</td>
<td>1.178</td>
<td>.278*</td>
<td>3.46</td>
<td>0.87</td>
<td>387</td>
<td>1.453</td>
<td>.147</td>
</tr>
<tr>
<td>Skills</td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.32</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Ability</td>
<td>Pass</td>
<td>0.473</td>
<td>.492*</td>
<td>3.21</td>
<td>1.09</td>
<td>387</td>
<td>1.668</td>
<td>.096</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.01</td>
<td>1.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Relevance</td>
<td>Pass</td>
<td>1.709</td>
<td>.192*</td>
<td>3.05</td>
<td>1.26</td>
<td>387</td>
<td>1.706</td>
<td>.089</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
<td></td>
<td></td>
<td>2.82</td>
<td>1.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>Fail</td>
<td></td>
<td></td>
<td>3.56</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: For pass, \( n = 272 \); for fail, \( n = 117 \).

*Pooled (equal)-variance \( t \) test; \# Separate-variance \( t \) test.

*Significant at the 0.05 level (Reject \( H_0 \)).

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However, the null hypothesis was retained for all the other variables. For these eight variables the means (on a scale of 1 to 5) for successful and unsuccessful students ranged from 3.05 to 3.76 and 2.82 to 3.56 respectively. The means for the successful students were generally higher than those of the unsuccessful students.

Null Hypothesis 6

Null hypothesis 6 states: There is no linear combination of the independent variables regarding possession that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

The independent variables were: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, and professor quality. This hypothesis was tested by discriminant analysis.

Discriminant analysis using the stepwise variable selection method was used to ascertain the variable(s) possessed, which discriminated between successful and unsuccessful students. The smallest Wilks’s lambda and the $F$ statistics were used to select variables for entry and removal from the model. In addition, the model was tested for its effectiveness in variable selection by examining the number of cases classified correctly.

Table 18 shows that the possession of practice was the only variable included in the discriminant function of the nine variables that were entered. The level of significance was 0.024. Therefore the null hypothesis was rejected. Hence, the discriminant function indicates that students who practice mathematics more are more likely to be successful.
### TABLE 18

**CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS REGARDING POSSESSION OF VARIABLES THAT DISCRIMINATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL STUDENTS USING WILKS'S LAMBDA**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variable</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Possession of Practice</td>
<td>1.028</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-3.469</td>
<td></td>
</tr>
</tbody>
</table>

**Group Means (Centroids) for Discriminant Functions**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Students</td>
<td>0.075</td>
</tr>
<tr>
<td>Unsuccessful Students</td>
<td>-0.175</td>
</tr>
</tbody>
</table>

**Wilks's Lambda**

<table>
<thead>
<tr>
<th>Wilks' Lambda</th>
<th>Canonical Correlation</th>
<th>Chi-square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.987</td>
<td>0.114</td>
<td>5.080</td>
<td>1</td>
<td>.024</td>
</tr>
</tbody>
</table>

**Classification Results (Students)**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Actual No. of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Successful</td>
<td>272</td>
<td>150 (55.1%)</td>
</tr>
<tr>
<td>Unsuccessful</td>
<td>117</td>
<td>46 (39.3%)</td>
</tr>
</tbody>
</table>

*Note. 56.8% of cases correctly classified.*
Null Hypothesis 7

Null hypothesis 7 states: There is no linear combination of the cognitive variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

These cognitive variables were: out-of-class group work, out-of-class individual work, active class participation, clarification of unclear issues with professor, use of calculus 1 principles in everyday out-of-class activities, analysis of calculus 1 principles and concepts, exploring new ways of solving problems, consistent out-of-class study routine, and revision of principles immediately after they are taught. This hypothesis was tested by discriminant analysis.

Discriminant analysis using the stepwise variable selection method was used to ascertain the cognitive variable(s) that discriminated between successful and unsuccessful students. The smallest Wilks’s lambda and the $F$ statistics were used to select variables for entry and removal from the model. In addition, the model was tested for its effectiveness in variable selection by examining the number of cases classified correctly.

Table 19 shows that three of the nine variables entered were included in the discriminant function. These variables were active class participation, consistent out-of-class study routine, and use of calculus principles in everyday life. The standardized discriminant coefficients showed the relative strength of the three variables in the model. Active class participation had the highest contribution to the model with discriminant coefficient of 0.694. The level of significance was 0.001. Therefore the null hypothesis was rejected. The classification table indicated that 57.3% of the students were correctly classified.
**TABLE 19**

CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS REGARDING COGNITIVE VARIABLES THAT DISCRIMINATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL STUDENTS USING WILKS'S LAMBDA

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variables</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Active Class Participation</td>
<td>0.390</td>
<td>0.694</td>
</tr>
<tr>
<td>2</td>
<td>Consistent out of Class Study Routine</td>
<td>0.364</td>
<td>0.657</td>
</tr>
<tr>
<td>3</td>
<td>Use of Principles in Everyday Life</td>
<td>-0.364</td>
<td>-0.538</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-2.209</td>
<td></td>
</tr>
</tbody>
</table>

Group Means (Centroids) for Discriminant Functions

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Students</td>
<td>0.139</td>
</tr>
<tr>
<td>Unsuccessful Students</td>
<td>-0.323</td>
</tr>
</tbody>
</table>

Wilks's Lambda

<table>
<thead>
<tr>
<th>Wilks' Lambda</th>
<th>Canonical Correlation</th>
<th>Chi-square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.957</td>
<td>0.208</td>
<td>17.041</td>
<td>3</td>
<td>.001</td>
</tr>
</tbody>
</table>

Classification Results (Students)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Actual No. of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Successful</td>
<td>272</td>
<td>153 (56.3%)</td>
</tr>
<tr>
<td>Unsuccessful</td>
<td>117</td>
<td>47 (40.2%)</td>
</tr>
</tbody>
</table>

*Note: 57.3% of cases correctly classified.*
The discriminant function suggests that a student who actively participates in class, has a consistent out-of-class study routine, but does not use calculus principles in everyday life is more likely to be successful than unsuccessful.

Null Hypothesis 8

Null hypothesis 8 states: There is no linear combination of the affective variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students. These affective variables were: professor’s help, relationship with other business calculus students, degree of comfort in business calculus class, fairness of business calculus professor, respectfulness of business calculus professor, and feeling of comfort at university. This hypothesis was tested by discriminant analysis.

Discriminant analysis using the stepwise variable selection method was used to ascertain the affective variable(s) that discriminated between successful and unsuccessful students. The smallest Wilks’s lambda and the $F$ statistics were used to select variables for entry and removal from the model. In addition, the model was tested for its effectiveness in variable selection by examining the number of cases classified correctly.

Table 20 shows that two of the six variables were included in the discriminant function. These variables were professor’s help and relationship with fellow students. The standardized discriminant coefficients showed the relative strength of the two variables in the model. Professor’s help had the higher contribution to the model with discriminant coefficient of 0.658. The level of significance was 0.000. Therefore the null hypothesis was rejected. The classification table indicated that 58.9% of the students were correctly classified.
TABLE 20

CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS REGARDING AFFECTIVE VARIABLES THAT DISCRIMINATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL STUDENTS USING WILKS'S LAMBDA

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variables</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Professor's Help</td>
<td>0.524</td>
<td>0.658</td>
</tr>
<tr>
<td>2</td>
<td>Relationship With Fellow Students</td>
<td>0.560</td>
<td>0.552</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td></td>
<td>-4.125</td>
</tr>
</tbody>
</table>

Group Means (Centroids) for Discriminant Functions

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Students</td>
<td>0.144</td>
</tr>
<tr>
<td>Unsuccessful Students</td>
<td>-0.334</td>
</tr>
</tbody>
</table>

Wilks' Lambda

<table>
<thead>
<tr>
<th>Wilks' Lambda</th>
<th>Canonical Correlation</th>
<th>Chi-square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.954</td>
<td>0.214</td>
<td>18.145</td>
<td>2</td>
<td>.000</td>
</tr>
</tbody>
</table>

Classification Results (Students)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Actual No. of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Successful</td>
<td>272</td>
<td>162 (59.6%)</td>
</tr>
<tr>
<td>Unsuccessful</td>
<td>117</td>
<td>50 (42.7%)</td>
</tr>
</tbody>
</table>

Note. 58.9% of cases correctly classified.
The discriminant function suggests that students who get help from their professor and have a good relationship with fellow students are more likely to be successful than unsuccessful.

Null Hypothesis 9

Null hypothesis 9 states: There is no linear combination of the perceptions of professors’ effectiveness variables that significantly discriminates between successful and unsuccessful Business Calculus 1 students.

These professor effectiveness variables were degree of clarity, motivation, excellence, fun, encouragement, availability, and supportiveness. This hypothesis was tested by discriminant analysis.

Discriminant analysis using the stepwise variable selection method was used to ascertain the professor effectiveness variable(s) that discriminated between successful and unsuccessful students. The smallest Wilks’s lambda and the $F$ statistics were used to select variables for entry and removal from the model. In addition, the model was tested for its effectiveness in variable selection by examining the number of cases classified correctly.

Table 21 shows that only professors’ clarity of the seven variables was included in the discriminant function. The level of significance was 0.006. Therefore the null hypothesis was rejected. The classification table indicated that 58.9% of the students were correctly classified. The discriminant function suggests that students whose professor’s clarity is high are more likely to be successful than unsuccessful.
### TABLE 21

**CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS REGARDING PROFESSOR EFFECTIVENESS VARIABLES THAT DISCRIMINATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL STUDENTS USING WILKS’S LAMBDA**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variable</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Professor’s Clarity</td>
<td>0.557</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-2.932</td>
<td></td>
</tr>
</tbody>
</table>

**Group Means (Centroids) for Discriminant Functions**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Students</td>
<td>0.093</td>
</tr>
<tr>
<td>Unsuccessful Students</td>
<td>-0.215</td>
</tr>
</tbody>
</table>

**Wilks’s Lambda**

<table>
<thead>
<tr>
<th>Wilks’ Lambda</th>
<th>Canonical Correlation</th>
<th>Chi-square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.980</td>
<td>0.140</td>
<td>7.678</td>
<td>1</td>
<td>.006</td>
</tr>
</tbody>
</table>

**Classification Results (Students)**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Actual No. of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Successful</td>
<td>272</td>
<td>160 (58.8%)</td>
</tr>
<tr>
<td>Unsuccessful</td>
<td>117</td>
<td>48 (41.0%)</td>
</tr>
</tbody>
</table>

*Note.* 58.9% of cases correctly classified.

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Null Hypothesis 10

Null hypothesis 10 states: There is no linear combination of all the variables (in hypotheses 1-9) that significantly discriminates between successful and unsuccessful Business Calculus 1 students in the three universities.

This hypothesis was tested by discriminant analysis. This hypothesis combines the variables of hypotheses 1 to 9. These variables were: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, cognitive factors, affective factors, and professor quality.

Discriminant analysis using the stepwise variable selection method was used to ascertain the variable(s) that discriminated between successful and unsuccessful students. The smallest Wilks's lambda and the $F$ statistics were used to select variables for entry and removal from the model. In addition, the model was tested for its effectiveness in variable selection by examining the number of cases classified correctly.

Table 22 shows that 3 of the 40 variables entered were included in the discriminant function. The standardized discriminant coefficients showed the relative strength of the three variables in the model. Professor's help had the highest contribution, with discriminant coefficient of 0.570. The level of significance was 0.000. Therefore the null hypothesis was rejected. The classification table indicated that 60.4% of the students were correctly classified.

The discriminant function suggests that students who get help from their professor, have a good relationship with fellow students, and participate in out-of-class individual study are more likely to be successful than unsuccessful.
TABLE 22

CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS REGARDING VARIABLES THAT DISCRIMINATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL STUDENTS USING WILKS'S LAMBDA

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variables</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Professor's Help</td>
<td>0.454</td>
<td>0.570</td>
</tr>
<tr>
<td>2</td>
<td>Out of Class Individual Study</td>
<td>0.346</td>
<td>0.510</td>
</tr>
<tr>
<td>3</td>
<td>Relationship With Fellow Students</td>
<td>0.460</td>
<td>0.454</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-5.285</td>
<td></td>
</tr>
</tbody>
</table>

Group Means (Centroids) for Discriminant Functions

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Students</td>
<td>0.167</td>
</tr>
<tr>
<td>Unsuccessful Students</td>
<td>-0.388</td>
</tr>
</tbody>
</table>

Wilks' Lambda

<table>
<thead>
<tr>
<th>Wilks' Lambda</th>
<th>Canonical Correlation</th>
<th>Chi-square</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.939</td>
<td>0.247</td>
<td>24.282</td>
<td>3</td>
<td>.000</td>
</tr>
</tbody>
</table>

Classification Results (Students)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Actual No. of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Successful</td>
<td>272</td>
<td>160 (58.8%)</td>
</tr>
<tr>
<td>Unsuccessful</td>
<td>117</td>
<td>48 (41.0%)</td>
</tr>
</tbody>
</table>

Note: 60.4% of cases correctly classified.
Null Hypothesis 11

Null hypothesis 11 states: There is no change of attitude after doing Business Calculus 1. Cross tabulation and chi-square were used to test this hypothesis.

Table 23 shows the relationship between Business Calculus 1 grade and attitude towards calculus.

### TABLE 23

**EFFECT OF CALCULUS GRADE ON ATTITUDE TOWARDS CALCULUS (CROSS TABULATION)**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Change of Attitude Since Taking Calculus</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>No Change</td>
<td>Positive</td>
<td></td>
</tr>
<tr>
<td>Successful</td>
<td>Actual</td>
<td>17</td>
<td>101</td>
<td>154</td>
<td>272</td>
</tr>
<tr>
<td></td>
<td>Expected</td>
<td>(18.9)</td>
<td>(109.8)</td>
<td>(143.3)</td>
<td></td>
</tr>
<tr>
<td>Unsuccessful</td>
<td>Actual</td>
<td>10</td>
<td>56</td>
<td>51</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Expected</td>
<td>(8.1)</td>
<td>(47.2)</td>
<td>(61.7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>27</td>
<td>157</td>
<td>205</td>
<td>389</td>
</tr>
</tbody>
</table>

Table 23 also shows that for positive attitude change, the actual and expected values for successful students were 154 and 143.3 respectively and unsuccessful students 51 and 61.7 respectively. While for negative attitude change, the actual and expected values for successful students were 17 and 18.9 respectively and unsuccessful students 10 and 8.1 respectively. There appears to be a relationship between calculus grade and
change of attitude since taking the course in that successful students' actual positive attitude change was greater than expected, while actual negative attitude change was less than expected. On the contrary, unsuccessful students' actual positive attitude change was less than expected while actual negative attitude change was greater than expected. It may be concluded that successful students' positive attitude toward Business Calculus 1 increases, while unsuccessful students' negative attitude increases.

However, based on the cross tabulation, it could not be concluded that the apparent relationship between students' performance and attitude was significant. Therefore the chi-square was used to test the level of significance. The resultant chi-square was 5.259, with 2 degrees of freedom, and a level of significance of 0.072. Therefore the null hypothesis was retained, because the relationship between attitude change and doing Business Calculus 1 was not significant.

Summary

This chapter analyzed data from the sample of 389 Business Calculus 1 students and their 12 professors in three Jamaican universities. The following demographic information was presented for the students: gender, stage in their program (year), last educational institution attended, grade on first attempt at Business Calculus 1, grade on first attempt at CXC mathematics (general proficiency), father's education, mother's education, cumulative GPA, and program of study/major. No demographic information was presented for the professors. The chapter also presented the analysis of the eight research questions and the eleven related hypotheses.

Hypothesis 1 examined whether there was any significant difference between the perceptions of students and their professors in the three universities regarding the degree
of importance of the dependent variables to the successful completion of the first course in business calculus.

There was a significant difference between students and professors in the three Jamaican universities regarding the importance of relevance. The null hypothesis was rejected for this variable. However, the null hypothesis was retained for the other eight variables.

Hypothesis 2 tested whether there was any linear combination of the independent variables regarding importance that significantly discriminated between Business Calculus 1 students and their professors in the three universities.

The importance of relevance was the only variable included in the discriminant function of the nine variables that were entered. The level of significance was 0.042. Therefore the null hypothesis was rejected.

Hypothesis 3 examined whether there was any significant difference between the perceptions of successful and unsuccessful students in the three universities regarding the degree of importance of the dependent variables to the successful completion of the first course in business calculus.

There was a significant difference between successful and unsuccessful students in the three Jamaican universities regarding the importance of no anxiety. The null hypothesis was rejected for this variable. However, the null hypothesis was retained for the other eight variables.

Hypothesis 4 tested whether there was any linear combination of the independent variables regarding importance that significantly discriminated between successful and unsuccessful Business Calculus 1 students in the three universities.
The importance of no anxiety was the only variable included in the discriminant function of the nine variables that were entered. The level of significance was 0.039. Therefore the null hypothesis was rejected

Hypothesis 5 examined whether there was any significant difference in the perceptions of successful and unsuccessful students in the three universities regarding their degree of possession of the dependent variables considered necessary for the successful completion of Business Calculus 1.

There was a significant difference between successful and unsuccessful students in the three Jamaican universities regarding the possession of practice. The null hypothesis was rejected for this variable. However, the null hypothesis was retained for the other eight variables.

Hypothesis 6 tested whether there was any linear combination of the independent variables regarding possession that significantly discriminated between successful and unsuccessful Business Calculus 1 students.

The possession of practice was the only variable included in the discriminant function of the nine variables that were entered. The level of significance was 0.024. Therefore the null hypothesis was rejected

Hypothesis 7 examined whether there was any linear combination of the cognitive variables that significantly discriminated between successful and unsuccessful Business Calculus 1 students.

Three of the nine variables entered were included in the discriminant function. These variables were active class participation, consistent out-of-class study routine, and use of calculus principles in everyday life. Active class participation had the highest
contribution to the discriminant function with discriminant coefficient of 0.694. The level of significance was 0.001. Therefore the null hypothesis was rejected.

Hypothesis 8 tested whether there was any linear combination of the affective variables that significantly discriminated between successful and unsuccessful Business Calculus 1 students.

Two of the six variables entered were included in the discriminant function. These variables were professor’s help and relationship with fellow students. The level of significance was 0.000. Therefore the null hypothesis was rejected.

Hypothesis 9 examined whether there was any linear combination of the perceptions of professor’s effectiveness variables that significantly discriminated between successful and unsuccessful Business Calculus 1 students.

Professor’s clarity, of the seven variables entered, was included in the discriminant function. The level of significance was 0.006. Therefore the null hypothesis was rejected.

Hypothesis 10 tested whether there was any linear combination of all the variables (in hypotheses 1-9) that significantly discriminated between successful and unsuccessful Business Calculus 1 students in the three universities.

Three of the 40 variables entered were included in the discriminant function. These variables were professor’s help, out-of-class individual study, and relationship with fellow students. Professor’s help had the highest contribution to the discriminant function with discriminant coefficient of 0.570. The level of significance was 0.000. Therefore the null hypothesis was rejected.
Hypothesis 11 tested whether there was a change of attitude after doing Business Calculus 1.

The null hypothesis was retained. There was no significant change of attitude after doing Business Calculus 1.
CHAPTER V

SUMMARY, DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

This chapter has three sections. First, a summary of the study is presented, second, the implications of the findings are discussed, and lastly the recommendations for research and practice are outlined.

Summary of the Study

This study looked at variables related to the successful completion of the first course in business calculus at Jamaican universities. To accomplish this objective the study measured the perceptions of Business Calculus 1 students and their professors to determine the extent to which they believed certain variables were important for success in Business Calculus 1. The study also looked at students' perceptions of their possession of these variables.

The study sought answers to the following research questions:

1. What variables do students and their professors perceive to be important for success in the first course in business calculus?

2. Is there a significant difference in the perceptions of successful students and unsuccessful students regarding the variables perceived necessary for successful completion of the first course in business calculus?

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3. Is there a significant difference in the perceptions of successful and unsuccessful students regarding the degree to which they possess these variables?

4. Is there a significant difference between successful and unsuccessful students' cognitive processes regarding Business Calculus 1?

5. Is there a significant difference between successful and unsuccessful students' affective factors regarding Business Calculus 1?

6. Is there a significant difference in perceptions of successful and unsuccessful students regarding the effectiveness of their Business Calculus 1 professors?

7. To what extent do the variables of mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem solving-skills, ability, relevance, professor quality, cognitive factors, affective factors, and professor effectiveness differentiate between successful and unsuccessful students?

8. Do students' attitudes toward Business Calculus 1 change after doing the course?

Overview of the Literature

The review of the literature revealed that poor mathematics performance is a problem both in Eastern and Western countries (Malaty, 1998). Mathematics underperformance is also a problem in Jamaica (Jamaica Ministry of Education & Culture, 2000; Jamaica Ministry of Education, Youth, & Culture, 1996). While this is taking place the job market in a technologically advanced world requires people with well-developed quantitative, critical thinking, problem-solving, creative thinking, reasoning, analytical, and presentation skills (Caissey, 1990; Joyce & Voytek, 1996; Levenburg, 1996; Van Horn, 1995). Business Calculus 1 is a very critical course in the
undergraduate business curricula of universities as students seek to develop these skills for the job market. Business Calculus 1 also provides a quantitative foundation for critical upper-level courses such as economics, business and economic statistics, quantitative business analysis, production and operations management, and financial management (Kasten et al., 1988).

Success in Business Calculus 1 in particular and mathematics in general has been found to be related to mathematics background, practice, absence of mathematics anxiety, positive attitude towards calculus, thinking skills, problem-solving skills, ability, relevance, cognitive factors, affective factors, and professor quality (Arismendi-Pardi, 1997; Cox, 1993; England, 2001; MacKay, 1982; Maysick, 1984; Norma & Rendon, 1990; U.S. Department of Education, 1997).

A number of initiatives have been undertaken to improve mathematics performance both in Jamaica and the United States leading to standards for teaching K-12 mathematics. These standards focus on developing problem-solving skills rather than rote learning, thinking and reasoning skills in real-life context, creativity and enquiry, investigating skills, mathematics communication skills, and a student-centered environment which empowers students.

The literature on innovative ways of teaching mathematics identifies constructivist approaches such as cooperative learning, expressive writing and speaking, calculator-based instruction, computer assisted instruction, hands-on teaching, history in mathematics, and individualized instruction as effective ways of achieving the objectives of the standards. Constructivists argue that the use of these methods will result in the improvement in mathematics performance.
Methodology

This study utilized a survey design method to find out from students and their professors their perceptions of the factors that contribute to success in the first course in business calculus. Two instruments were used for data collection. The students' copy had six sections dealing with importance of variables, possession of variables, cognitive variables, affective variables, professor effectiveness variables, and demographic variables. The professors' copy had only one section dealing with importance of variables for success. The sample for this study was made up of 389 Business Calculus 1 students and 12 of their professors. The samples were taken from intact classes at three Jamaican universities.

To provide answers for research question 1, the respondents' responses to the level of importance of each of the nine variables in section 1 of the questionnaire were rank ordered from 1 to 9. Responses to the 5-point Likert scale regarding importance of variables were rated as follows: 1.00-2.75, little importance; 2.76-3.75, some importance; and 3.76-5.00, much importance. In addition, the independent sample t test, cross tabulation, chi-square, and discriminant analysis were used to answer the eight research questions and test the 11 related hypotheses. The analyses of the results were done using the Statistical Package for the Social Sciences (SPSS) version 10.0.

Demographic Information

Data were collected from the following institutions. Institution A is a private liberal arts university in central Jamaica with student enrollment of approximately 3,500 at the time of this study. Institution B is a public university in Kingston with student enrollment of approximately 8,000 at the time of this study. Lastly, institution C is also a
public university in Kingston with approximately 10,000 students enrolled at the time of this study.

A total of 650 students and faculty from the three universities were sampled. A total of 630 questionnaires were distributed to students who did business calculus in 2000/2001 of which 389 usable ones were collected, resulting in a return rate of 61.7%. Regarding faculty, 20 questionnaires were distributed of which 12 usable ones were returned, resulting in a return rate of 60.0%. No demographic information was requested from the faculty.

The demographic information of the students revealed the following. The students’ majors reflected the following: accounting 35.7%; management 34.4%; marketing 10.0%; finance 6.9%; and other 12.9%. Of the 389 students sampled, 31.1% were males while 68.9% were females. The majority of the students did Business Calculus 1 in year one-83.5%. Most (67.1%) of the students attended high school just before enrolling at universities.

The sample revealed that 69.9% of the students were successful when they attempted Business Calculus 1 for the first time while 30.1% were unsuccessful. The cumulative GPA of the students showed that 8.0% had a below average GPA (< 2.50), 77.7% average (2.50 to 3.49), 9.7% cum laude (3.50 to 3.74), 1.7% magna cum laude (3.75 to 3.89), and 2.9% summa cum laude (3.90 to 4.00).

Eighty-one percent of the students were successful when they first attempted the CXC mathematics examinations while 19% were unsuccessful. In reporting their father’s highest level of education the students reported the following: 19.3% primary, 58.0% secondary, 15.2% first degree, 6.4% master’s degree, and 1.1% doctoral. In reporting
their mother’s highest level of education the students reported the following: 14.2% primary, 61.9% secondary, 18.1% first degree, 4.9% master’s degree, and 0.8% doctoral.

Findings, Interpretation, and Discussion Regarding Students’ and Faculty’s Perceptions of Success Factors for First Course in Business Calculus

Findings of this study were based on students’ and their professors’ perceptions of the importance of the following variables for success in the first course in business calculus: mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, and professor quality. Findings were also based on students’ perceptions of the degree to which they possessed the above variables and how they were affected by cognitive, affective, and professor effectiveness variables.

Research Question 1

Question 1 asked: What variables do students and their professors perceive to be important for success in the first course in business calculus?

Both students and their professors within the three Jamaican universities perceived all the variables to be important for Business Calculus 1 success. The means for the students and professors ranged from 3.15 to 4.37 and 3.50 to 4.58 respectively.

Generally, the professors rated the skills more highly than the students. This finding is consistent with Williams (1998) and Heskin, Cheng, and Sharma (1994) whose research showed that professors rated academic skills higher than the students.

The students ranked and rated the top five skills as practice, professor quality, positive attitude, mathematics background, and problem-solving skills (see Tables 9 & 10, pp. 79, 80), whereas the professors ranked and rated the top five skills as problem
solving, practice, thinking, positive attitude, and mathematics background (see Tables 11 & 12, pp. 82, 83). This suggests that professors place more emphasis on thinking skills and less emphasis on professors’ quality than do students. This finding is consistent with the complaints in educational institutions that many students are overly dependent on their professors for knowledge instead of thinking for themselves. This could affect professors’ attempts to emphasize both thinking skills and the need for students to take responsibility for their own success.

This study is consistent with Smith (1998), who suggested that one of the most important qualities affecting students’ success in mathematics is attitude. In addition, these findings are supported by research conducted by Arismendi-Pardi (1997), Keeley et al. (1994), and Sadrak (1985), which found a positive relationship between mathematics background and achievement. However, the results of this study contradict Lavin (1965), who noted that ability measures are the best single type of success predictors.

In addition, hypotheses 1 and 2, which also examined this research question reflected that the only significant difference between professors and students was with the variable relevance. The findings suggest that professors see relevance as being more important for success than do students. It may be that the professors have not been successful at convincing the students of the relevance of Business Calculus 1.

Research Question 2

Question 2 asked: Is there a significant difference in the perceptions of successful and unsuccessful students regarding the variables perceived necessary for successful completion of the first course in business calculus?
The findings from hypotheses 3 and 4, which examined this question, showed that successful and unsuccessful students in the three Jamaican universities differed significantly only on the variable anxiety. Successful students considered an anxiety-free learning environment to be more important for success than their unsuccessful counterparts. In general, the successful students rated the importance of the other eight variables more highly than did the unsuccessful students.

However, both successful students (with mean scores of 3.95 to 4.37) and unsuccessful students (with mean scores of 3.95 to 4.38) assigned high importance to all the variables, with the exception of ability and relevance.

I found no other literature sources that reported that successful students perceived an anxiety-free environment as more important than unsuccessful students do. Perhaps unsuccessful students do not recognize the importance of their emotions in the learning process.

**Research Question 3**

Question 3 asked: Is there a significant difference in the perceptions of successful and unsuccessful students regarding the degree to which they possess these variables?

The findings from hypotheses 5 and 6, which examined this question, showed that successful and unsuccessful students in the three Jamaican universities differed significantly only on the possession of the variable practice. Successful students perceived that they possessed more of the variable practice than their unsuccessful counterparts. This study is consistent with Chambers (2000) who suggested that sustained practice is important for the mastery of mathematical concepts and ultimately success. In addition, this study supports Marzano and Pickering (1997) who suggested
that both massed and distributed practice are important for success in procedural knowledge courses such as mathematics. In general, the successful students perceived that they possessed the other eight variables more than their unsuccessful counterparts.

A comparison of the degree of importance and possession of the variables shows that both successful and unsuccessful students rated the importance of the variables more highly than the degree to which they possessed them. For successful students the mean scores for importance and possession of the variables ranged from 3.03 to 4.37 and 3.05 to 3.76 respectively, whereas for unsuccessful students the mean scores for importance and possession of the variables ranged from 3.03 to 4.38 and 2.82 to 3.56 respectively.

This suggests that even though the students consider the variables to be important, they do not feel that they have sufficient mastery of them. This may mean that the students will be willing to take the necessary steps to acquire these skills. It could also mean that the students are not inclined to acquire these skills even though they consider them important for success. In other words, they may not be motivated by the possibility of success in Business Calculus 1.

Another implication of this difference between the degree of importance ascribed to the variables by the students and the extent to which they perceived that they possessed them is that these students were not adequately prepared by secondary and primary schools for university-level mathematics. The Jamaican primary-school system is plagued with inadequate numbers of certified mathematics teachers and lack of adequate teaching/learning materials (Jamaica Ministry of Education, 1977). The secondary-school system has insufficient numbers of adequately trained mathematics teachers,
insufficient mathematics teachers in training, and a low percentage of trained mathematics teachers returning to the classrooms (Powell, 1994).

Yet another possible implication is that the skills required for secondary- and primary-school mathematics are different from those needed at the tertiary level.

Research Question 4

Question 4 asked: Is there a significant difference between successful and unsuccessful students’ cognitive processes regarding Business Calculus 1?

The findings from hypothesis 7, which examined this question, showed that successful and unsuccessful students in the three Jamaican universities differed significantly on a combination of the cognitive variables active class participation, consistent out-of-class study routine, and use of calculus principles in everyday life. The results indicate that students who actively participate in class, have consistent out-of-class study routines, and do not use calculus principles in everyday life are likely to be successful. It is noteworthy that the use of Business Calculus 1 principles in everyday life is included negatively in the discriminant function. A possible explanation for this apparent contradiction could be that students who used Business Calculus 1 principles in everyday life may have been overconfident about their grasp of the course and therefore did not study as much as the others. Another explanation could be that the students’ perceptions of their use of Business Calculus 1 principles in everyday life may be wrong.

In general, the successful students were more involved in the use of the other six cognitive variables than their unsuccessful counterparts. Additionally, the mean scores for the cognitive variables for both successful and unsuccessful students were just above the average level. These relatively low cognitive scores, especially of the successful
students, suggest that cognitive variables were not solely responsible for success in Business Calculus 1.

The findings of this study support Cox (1993) who found that successful students were more involved in out-of-class individual work and active class participation than their unsuccessful counterparts.

Research Question 5

Question 5 asked: Is there a significant difference between successful and unsuccessful students' affective situations regarding Business Calculus 1?

The findings from hypothesis 8, which examined this question, showed that successful and unsuccessful students in the three Jamaican universities differed significantly on a combination of the affective variables professor’s help and relationship with fellow students. It may be concluded that students who have a supportive learning environment are likely to be successful. These findings support Mortimore et al. (1986) and Teddlie and Stringfield (1993) whose research found that an important element of effective classroom practices is the perception that professors care and provide help. This study is also consistent with a yearlong study by MacKay (1982), which concluded that there was a positive relationship between students’ achievement and professors being caring, accepting, and valuing students. It is also consistent with Marzano and Pickering (1997) who noted in their first dimension of learning that a positive classroom climate, which includes being accepted by peers and professors, enhances success.

However, the high mean scores for both successful and unsuccessful students suggest that affective variables were not the only distinguishing factors between success and failure in Business Calculus 1.
Research Question 6

Question 6 asked: Is there a significant difference in perceptions of successful and unsuccessful students (in Business Calculus 1) regarding the effectiveness of their Business Calculus 1 professors?

The findings from hypothesis 9, which examined this question, showed that successful and unsuccessful students in the three Jamaican universities differed significantly only on the professor effectiveness variable professor’s clarity. This implies that professors will need to focus more attention on the clarity of their delivery in order to be more effective.

This study is consistent with Sammons et al. (1995) whose review of British and North American research literature found professor’s clarity to be essential for purposeful teaching and hence success.

Research Question 7

Question 7 asked: To what extent do the variables mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, ability, relevance, professor quality, cognitive factors, affective factors, and professor effectiveness variables differentiate between successful and unsuccessful students?

The findings from hypothesis 10, which examined this question, showed that successful and unsuccessful students in the three Jamaican universities differed on a combination of the variables professor’s help, out-of-class individual study, and relationship with fellow students. These findings are consistent with those of research questions 4 and 5. Of the three variables that significantly differentiated between
successful and unsuccessful students, two were affective, one was cognitive, and none related to professor effectiveness. This suggests that the students perceived that affective variables are more important for success in Business Calculus 1 than cognitive and professor effectiveness variables.

Research Question 8

Question 8 asked: Do students' attitudes toward Business Calculus 1 change after doing the course?

The findings from hypothesis 11, which examined this question, suggested that there is a relationship between calculus grade and change of attitude since taking the course, in that successful students' actual positive attitude change was greater than expected while actual negative attitude change was less than expected. On the contrary, unsuccessful students' actual positive attitude change was less than expected while actual negative attitude change was greater than expected. However, the chi-square results suggested that the relationship was not significant.

From the cross tabulation it is suggested that successful students' positive attitude toward Business Calculus 1 may increase while unsuccessful students' negative attitude may increase. This finding suggests that attitude may not just affect performance (Benbow & Stanley, 1982; Norma & Rendon, 1990) but may also be affected by performance (Hendel, 1980). This is consistent with Wambach (1993) who noted that favorable attitudes result in achievement, and achievement results in favorable attitude.

Summary of the Findings

This study sought to ascertain the perceptions of Business Calculus 1 students and
their professors regarding variables that they consider important for the successful completion of Business Calculus 1. The following findings were garnered from the study:

1. Students of the three universities perceived that mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, and professor quality were of much importance for success. However, they perceived that ability and relevance were of some importance.

2. Professors of the three universities perceived that all the above variables except ability were of much importance. They perceived that ability was of some importance.

3. In general, the professors rated the importance of the above variables more highly than the students in the three universities.

4. Both successful and unsuccessful students perceived the importance of the above variables more highly than their possession of them.

5. Both successful and unsuccessful students' cognitive scores were generally just above average while their affective scores were generally high.

6. There was a significant difference between students and their professors in the three universities regarding the variable relevance for success in Business Calculus 1.

7. The students seem to think that affective variables were more important for success in Business Calculus 1 than cognitive and professor effectiveness variables.

8. The three universities reflected significant differences between successful and unsuccessful Business Calculus 1 students regarding the variables anxiety, active class
participation, consistent out-of-class study routine, professor’s help, relationship with fellow students, professor’s clarity, and possession of practice.

9. Successful students’ mean scores for cognitive, affective, and professor effectiveness variables were generally higher than those of unsuccessful students.

10. Successful students’ attitude towards Business Calculus 1 improved whereas unsuccessful student attitude became more negative.

**Implications for Teaching and Learning of Mathematics (Business Calculus)**

Learning involves a partnership between teachers, parents, and students (Arthur, 2000). Students must be interested in their own learning for even the best teaching methods to be effective. However many studies about students’ performance/learning, in general, and mathematics learning, in particular, tend to ignore the students’ role in their learning. This study focused on learning of mathematics from the students’ perspective. It looked at the effect of students’ eco-systems, circumstances, and approaches on their performance.

**Implications for Theory**

This study suggests that students and professors perceive that mathematics background, practice, absence of mathematics anxiety, positive attitude, thinking skills, problem-solving skills, and professor quality are of much importance for success in Business Calculus 1. However, the students are likely to perceive that ability and relevance are of some importance while the professors would likely rate ability of some importance. In general, professors are likely to rate the importance of the variables more highly than students do.
Both successful and unsuccessful students perceived the importance of the above variables more highly than their possession of them. This suggests that even though the students consider the variables to be important, they do not feel that they have sufficient possession of them. This may mean that the students will be willing to take the necessary steps to acquire these skills. It could also mean that the students are not inclined to acquire these skills even though they consider them important for success. In other words, they may not be motivated by the possibility of success in mathematics.

Both successful and unsuccessful students' cognitive scores were generally just above average while their affective scores were generally high. Affective variables were perceived by the students to be more important for success in Business Calculus 1 than cognitive and professor effectiveness variables. In general, successful students had better cognitive, affective, and professor effectiveness variables than unsuccessful students. It seems as if success in mathematics is dependent on a combination of positive cognitive, affective, and professor quality variables with affective variables being the most essential. Marzano and Pickering (1997) noted, “All learning takes place against the backdrop of learners’ attitudes and perceptions” (p. 7).

There was a significant difference between students and their professors regarding the variable relevance for success in Business Calculus 1. This could explain why many students are not inclined to do Business Calculus 1. Therefore, one can expect that professors will have a difficult task to convince students of the significance of Business Calculus 1 in the business curriculum.

The three universities reflected significant differences between successful and unsuccessful Business Calculus 1 students regarding the variables anxiety, active class
participation, consistent out-of-class study routine, professor’s help, relationship with fellow students, professor’s clarity, and possession of practice.

Lastly, successful students’ attitudes toward Business Calculus 1 improved while unsuccessful student attitudes got more negative.

Implications for Practice

The significant difference between professors and students regarding the variable relevance for success in Business Calculus 1 may be due to professors’ inability to convince students of the importance of Business Calculus for success in upper-level business courses such as Economics, Quantitative Business Analysis, and Financial Management and in the job market (Clarke, 1979). Universities need to heighten their students’ awareness of the relevance of mathematics to life in general and the job market in particular.

The findings that students considered affective variables more important than cognitive variables for success in Business Calculus 1 may be due to professors being able to pass on cognitive skills to their students while not realizing the need to exercise good interpersonal skills when interacting with students. In other words, this may be a reaction by students that while their professors are good in transmitting knowledge to them, they may not be as good with their interpersonal skills. This is understandable in that many professors are specialists in their subject areas but are not trained in the psychology of teaching. Consequently, attention needs to be focused on the affective effect of professor-to-student interactions.

There was a significant difference between successful and unsuccessful students regarding class participation. It could be that successful students were more motivated to
participate in class and have their concerns addressed than their unsuccessful counterparts. This is usually the case in lectures, which is still the predominant teaching method in universities (Cienkus & Ornstein, 1997; Goodlad, 1983; Meyers & Jones, 1993). Lectures do not facilitate broad-based participation (Johnson, Johnson, & Smith, 1998). Consequently universities may need to encourage teaching methods that facilitate more interactions among students, and between professors and students.

The significant difference between successful and unsuccessful students regarding professor's help may be due to the level of interactions between professors and students. In response to the open-ended question, students noted that more access to professors is important for success. The student-to-professor ratio was relatively high for the universities in this study. In addition, professors were expected to do other duties such as research, interact with the wider society, and sit on committees. It is therefore necessary that universities examine the workload of professors with a view to ensuring that students have adequate access to them.

Professor clarity also emerged as a distinguishing variable between successful and unsuccessful students. It is possible that professors are clear only to some students because they do not employ different approaches to teaching. Most professors use the lecture method (Cienkus & Ornstein, 1997; Goodlad, 1983; Meyers & Jones, 1993), which is suitable to students who are auditory learners, and who have a large store of information to which new learning can be related (Ausubel & Robinson, 1969). Lecturing assumes that all students need the same information, presented orally, at the same pace, without dialogue with the presenter, and in an impersonal way (Johnson, et al., 1998). However, students are usually at different stages of development and have

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different abilities and learning styles. This requires universities to adopt a more varied approach to teaching, which takes into account students’ different intelligences (Gardner, 1983), learning styles, and developmental stages. The educational system should be strengthened in order to conform more to the way different people learn (Berryman & Bailey, 1992).

Successful students were found to participate in consistent out-of-class study routine and practice of concepts more than unsuccessful students. These findings are consistent with Chambers (2000), who suggested that sustained practice is important for the mastery of mathematical concepts and ultimately success. In addition, Marzano and Pickering (1997) suggested that both massed and distributed practice is important for success in procedural knowledge-based courses such as mathematics. Therefore, universities should facilitate pedagogical approaches that require students to be consistently involved in practice and out-of-class studies.

As is borne out by this study, many students do not do well at mathematics because of high levels of anxiety. These anxieties include gender, test, evaluation, trait, state anxiety, and level of mathematics ability (Rabalais, 1998). Professors who are not motivating sometimes aggravate these anxieties. However, studies show that if professors raise their expectations of students, they (students) would become less anxious and improve their performance (Good, 1987; MacKay, 1982; Wineburg, 1987). Also, as suggested by many students in the questionnaire, teachers need to be more caring and sensitive to students’ fear of mathematics.
Recommendations

As a result of this study the following recommendations are made for future research and practice.

Recommendations for Future Research

1. This study should be replicated within the wider Caribbean region in order to see the effect (if any) of a larger sample on the results.

2. This study should be replicated in other countries. This would provide a basis of comparison among countries.

3. The study should be done at the high-school level to see if mathematics success factors are different between university-level and high-school students. The findings from this research would help to ensure that university entrants are better equipped for university mathematics courses.

4. This study should be replicated at the (business school) graduate level. This would give insight into whether changes in students’ perceptions occur between undergraduate and graduate studies.

5. A longitudinal study should be done to see if students’ perceptions of the relevance of Business Calculus 1 change as they move from undergraduate, to graduate, and to the working environment.

6. This study should be done using a causation approach to ascertain the factors that cause students to be successful or unsuccessful.

7. This study should be replicated within other disciplines at the university level. This would provide a basis of comparison among disciplines.

8. A study should be done to determine the effect of underperformance of
university graduates in mathematics on the job market and economy growth.

9. A study should be done to determine the approaches used to teach mathematics in Jamaican primary and high schools and their impact on students’ performance in mathematics. This could help policy makers to address the underperformance of many students in mathematics.

10. A study should be done to see at what level of the education system students tend to develop a phobia for mathematics and the reasons behind this phobia. This would help to enhance a more positive attitude towards mathematics and hopefully improve the level of performance.

11. A study should be done to ascertain the effect of using calculators (technology) on students’ mathematical cognitive processes. This would help educators to determine the appropriate place of calculators (technology) in the mathematics curricula of schools, given our technologically advanced world.

Recommendations for Practice

1. Educational institutions need to ensure that teachers do an assessment of students’ state of readiness at the beginning of each mathematics course in order to properly address their specific mathematics needs.

2. University professors need to use a wide variety of mathematics teaching methods (such as cooperative learning, expressive writing and speaking, calculator-based instruction, computer assisted instruction, and hands-on teaching) in order to cater to the needs of different students and encourage more student interactions.

3. Educational institutions need to provide opportunities for students to articulate and resolve their fear of mathematics.
4. Educational institutions need to incorporate the use of technology in the teaching and learning of mathematics.

5. Universities need to heighten their students' awareness of the relevance of mathematics to life in general and the job market in particular.

6. The Ministry of Education of Jamaica needs to implement a program to improve the teaching and learning of mathematics at the primary and secondary levels in order to provide a solid foundation for university-level mathematics. Critical to this process is the provision of qualified teachers who are evaluated on an ongoing basis to ensure quality control.

7. Educational institutions need to incorporate more relevant and concrete experiences in the mathematics curriculum thereby making the learning of mathematics concepts more attractive.

8. Universities need to provide staff development activities which focus on enhancing the interpersonal/affective skills of professors.

9. University professors should adopt a varied approach to teaching, which takes into account students' different intelligences, learning styles, and developmental stages.

10. University professors should require students to practice mathematics more by the increased use of activities such as worksheets and graded assignments.

11. University professors may need to look at ways to underscore the pervasiveness of mathematics by way of projects that look at the use of business calculus in everyday life.
APPENDIX A

STUDENT’S COPY OF INSTRUMENT
Survey of Business Calculus Performance Variables
STUDENT COPY

Completion of this Survey implies that you have consented to participate.

The purpose of this survey is to determine the extent to which certain variables impact the performance of students in the first course in business calculus.

SECTION 1: To what extent do you believe the following variables are important for success of your university students in general in the first course in business calculus?

Rate on a scale from 1 to 5 as follows: 1 (not important) to 5 (very important).

1. Mathematics background: previous mathematics knowledge which is relevant and useful to the learning of business calculus.


3. Absence of Mathematics Anxiety: being calm, positive, self-assured, and not apprehensive about business calculus.


5. Thinking Skills: ability to generate and weigh alternatives rationally. Also, ability to generate innovative, creative, and diverse ideas.

6. Problem Solving skills: ability to assess problem and devise a plan of action for its solution.

7. Ability: natural aptitude, talent, gift, or capacity to do mathematics.

8. Relevance: belief that business calculus is useful and applicable to life and career.

9. Professor quality: level of academic qualification, experience, competence, skill, and ability to generate interest in course.

10. From the nine variables above, please rank the two variables that you consider are most important for students' in Jamaican universities taking calculus 1:

   a. The most important variable for student success is # _____

   b. The next most important variable for student success is # _____

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SECTION 2 – Possession of variables
Please circle the number that best describe the degree to which you perceive you possessed the following skills when you started Business Calculus 1 class.

Rate on a scale from 1 to 5 as follows: 1 (no possession); 2 (little possession); 3 (moderate possession); 4 (much possession); and 5 (full possession).

1. Mathematics background: previous mathematics knowledge which is relevant and useful to the learning of business calculus.


3. Absence of Mathematics Anxiety: being calm, positive, self-assured, and not apprehensive about business calculus.

4. Positive Attitude: perceive business calculus to be manageable, and feeling capable of doing well. Motivated to perform.

5. Thinking Skills: ability to generate and weigh alternatives rationally. Also, ability to generate innovative, creative, and diverse ideas.

6. Problem Solving skills: ability to assess problem and devise a plan of action for its solution.

7. Ability: natural aptitude, talent, gift, or capacity to do mathematics.

8. Relevance: belief that business calculus is useful and applicable to life and career.

9. Professor quality: level of academic qualification, experience, competence, skill, and ability to generate interest in course.

10. From the nine variables above, please rank the two variables that you perceive you most possessed for success in business calculus 1 when you started classes.

   a. The variable I most possessed for success was # ___

   b. The variable I next most possessed for success was # ___

11. To what extent have your attitude towards business calculus 1 changed due to taking the course?

   ___ positive change  ___ no change  ___ negative change

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SECTION 3

To what extent were you involved in the following to enhance understanding/mastery of Business Calculus 1? Circle the **number** on a scale from ‘1’ to ‘7’ below.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Little/no Involvement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Extensive Involvement</th>
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<tbody>
<tr>
<td>1. Out of class group work</td>
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<td>2. Out of class individual study</td>
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<td>3. Active class participation</td>
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<td>4. Clarification of unclear issues with professor</td>
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<td>Extensive Involvement</td>
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<tr>
<td>5. Use of calculus 1 principles in everyday out of class activities</td>
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<td>6. Analysis of calculus 1 principles and concepts</td>
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<td>Extensive Involvement</td>
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<tr>
<td>7. Exploring new ways of solving problems</td>
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<td></td>
<td>Extensive Involvement</td>
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<tr>
<td>8. Consistent out of class study routine</td>
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<td></td>
<td>Extensive Involvement</td>
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<tr>
<td>9. Revision of (reflecting on) principles immediately after they are taught</td>
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<td></td>
<td></td>
<td>Extensive Involvement</td>
</tr>
</tbody>
</table>
SECTION 4
How do you feel about the following? Please circle: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree.

In general,

1. My calculus 1 professor was available to help me 1 2 3 4 5
2. I had a good relationship with my fellow Business Calculus 1 students 1 2 3 4 5
3. I felt comfortable in Business Calculus 1 class 1 2 3 4 5
4. The Business Calculus 1 professor was fair to me 1 2 3 4 5
5. The Business Calculus 1 professor was respectful to me 1 2 3 4 5
6. I felt comfortable at my university 1 2 3 4 5

SECTION 5: How would you rate the effectiveness of your Business Calculus 1 professor? Tick the appropriate space on each scale.

1. ClearConfusing
2. DemotivatingMotivating
3. ExcellentPoor
4. BoringFun
5. EncouragingDiscouraging
6. AvailableUnavailable
7. SupportiveUnsupportive

8. What is your overall rating of your professor's teaching effectiveness?
   _Excellent _Very good _Good _Fair _Poor

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Section 6: DEMOGRAPHIC CHARACTERISTICS

1. Identify your major by marking ticking: ___ Accounting ___ Management ___ Marketing ___ Finance ___ other (please state) ____________________.

2. Gender: ___ Male ___ Female.

3. Year when you did Business Calculus 1:
   ___ freshman ___ sophomore ___ junior ___ senior.

4. What is your approximate cumulative GPA (4 points) ______?

5. Please tick the last educational institution attended before your present one:
   ___ Secondary school ___ High school ___ Technical high school ___ Comprehensive high school ___ Teacher’s College ___ College ___ University ___________________________ other, please state.

6. Grade when you first attempted Business Calculus 1: ___

7. CXC (General proficiency) mathematics grade (first attempt): _____

8. Highest level of father’s education: ___ primary school ___ secondary school ___ has a first-degree ___ has a master’s degree ___ has a doctoral degree

9. Highest level of mother’s education: ___ primary school ___ secondary school ___ has a first-degree ___ has a master’s degree ___ has a doctoral degree

Please state any other variable(s) (not in this survey) that you think is important for success of students as a whole in the first course in business calculus.

________________________________________________________

Any other comments?
________________________________________________________
________________________________________________________
________________________________________________________

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APPENDIX B

PROFESSOR'S COPY OF INSTRUMENT
Survey of Business Calculus Performance Variables

FACULTY COPY

Completion of this Survey implies that you have consented to participate.

The purpose of this survey is to determine the extent to which certain variables impact the performance of students in the first course in business calculus.

SECTION 1: To what extent do you believe the following variables are important for success of your university students in general in the first course in business calculus?

Rate on a scale from 1 to 5 as follows: 1 (not important) to 5 (very important).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics background: previous mathematics knowledge which is relevant and useful to the learning of business calculus.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. Practice: rehearsal and repetition of concepts, methods, and approaches learnt in business calculus.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>3. Absence of Mathematics Anxiety: being calm, positive, self-assured, and not apprehensive about business calculus.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>4. Positive Attitude: perceive business calculus to be manageable, and feeling capable of doing well.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>5. Thinking Skills: ability to generate and weigh alternatives rationally. Also, ability to generate innovative, creative, and diverse ideas.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>6. Problem Solving skills: ability to assess problem and devise a plan of action for its solution.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>7. Ability: natural aptitude, talent, gift, or capacity to do mathematics.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>8. Relevance: belief that business calculus is useful and applicable to life and career.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>9. Professor quality: level of academic qualification, experience, competence, skill, and ability to generate interest in course.</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

10. From the nine variables above, please rank the two variables that you consider are most important for students' in Jamaican universities taking calculus 1:

   a. The most important variable for student success is #

   b. The next most important variable for student success is #
Please state any other variable(s) (not in this survey) that you think is important for success of students as a whole in the first course in business calculus.

______________________________

Any other comments?

______________________________

______________________________

______________________________

______________________________
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VITA

Martin Nkhrama Richards

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- 1992 – 1993  M.Sc. DEGREE IN ACCOUNTING (with Distinction) University of the West Indies
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- 1994 – 1996  Assistant Accountant/Project Coordinator Jamaica Mutual Life Assurance Society
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