RESEARCH REPORT

BOTSWANA EXAMINATIONS COUNCIL

Trends in International Mathematics and Science Study (TIMSS) 2011 - Form 2

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

2011

TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS)

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FOREWORD

Botswana, like many countries around the world, is repositioning itself in the global economy. There is recognition that Science and Technology will continue to be major drivers of the economy in the 21st century and that human capital has become a critical determinant of success in knowledge and the technologically driven economy. The Ministry of Education and Skills Development has therefore identified Mathematics and Science for special emphasis in its education and training programmes.

Education policy makers, planners and teachers require the use of research evidence as a basis for decision making in the quest for quality education. National and international surveys, school-based assessments, national examinations are all different sources of information for monitoring and evaluation of the quality of educational outcomes. The Trends in International Mathematics and Science Study (TIMSS) is an international project designed to generate information on Mathematics and Science achievements at the 4th and 8th grade levels as well as at advanced stages of learning. They also generate information on curriculum implementation, contexts of learning and successful pedagogical practice across all participating countries. Botswana started participating in TIMSS during the 2003 Cycle. The selection of TIMSS as an index for monitoring global competitiveness in Mathematics and Science learning and achievement was motivated by the national aspiration for a standard of education that is internationally competitive.

The TIMSS 2011 Report presents a wealth of information on Science and Mathematics curriculum coverage, the contexts of learning and the country's global competitiveness in Mathematics and Science achievement. The report presents sound research data that informs education strategy, curriculum and assessment, curriculum delivery, teacher development, supervision and educational management at school level, stakeholder involvement (i.e. parental involvement in the learning experiences of their children), and a myriad of comparative data from other education systems.

The only way to change the outcomes of our education system is to change what and how we educate. Planners, policy makers, teachers, parents, learners all need to effect changes that will improve the experiences of all learners and provide them with an opportunity to develop their potential and to contribute meaningfully to their own development and that of their country. I therefore invite you to read this report with an action oriented focus.

Prof Brian Mokopakgosi
Executive Secretary
Botswana Examinations Council

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Our sincere gratitude also goes to the Regional Offices that permitted us to conduct the study in schools in their regions. Our appreciation goes to the School Administrators whose high level of understanding of the significance of the study, permitted them to modify their tight schedules to accommodate us to administer the instruments. The successful conduct of the study hinges on the cooperation and preparations made by the School Coordinators, for both Field Test and Main Survey. BEC salutes your commitment to improving the education level of your country! We would like to thank all the teachers who participated in the completion of the questionnaires to have an insight into the teachers' variables that are linked to students' performance. Our biggest appreciation goes to the parents who permitted their children to take the tests, and completing the questionnaires to allow us to understand other variables at play in their children's learning.

Lastly, we thank all the Form 2 students who participated in this very important study. They were true ambassadors of this country; they represented other students and their country well. A great deal of acknowledgement also goes to all staff members of Botswana Examinations Council for the various roles each played in the project.

Data collection engaged a number of people from all walks of education. Some were instrument administrators, some acting as National Quality Control Monitors, while others acted as International Quality Control Monitors. There are so many to mention by name, all of them provided an important service. Thank you very much. We are also indebted to the teachers who helped in the scoring of both the pilot and the main study instruments (See Appendix A). At school level, School Coordinators handled all matters connected with the project and did it exceptionally well.

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EXECUTIVE SUMMARY

THE MEANING AND PURPOSE OF TIMSS

This is the fourth cycle of Trends in International Mathematics and Science Study (TIMSS) in which Botswana has participated. TIMSS is administered by the International Association for the Evaluation of Educational Achievement (IEA). The Association is composed of countries around the globe who are interested in finding out the extent to which their learners have mastered what they are taught in Mathematics and Science and how their learning achievements compare with those of learners at the same level in other countries. Forty-five countries and 14 benchmarking participants administered the eighth grade assessment.

The main objective of TIMSS is to assess what students around the world know and can do in Mathematics and Science, with the aim of providing a rich source of information to policy makers, education managers, curriculum developers, teacher trainers, teachers, assessment bodies, researchers and all stakeholders on the outcome of learning Mathematics and Science and on how the various factors surrounding the learners relate to learning achievement.

Another important objective of TIMSS is to compare the performance of students in the participating countries in Mathematics and Science and to assess how the various factors that impact on the learning of Mathematics and Science operate in different countries.

Why Botswana Participated in TIMSS 2011

The rationale for Botswana's participation in TIMSS has not changed from the 2003 and 2007 cycles. It is a national desire to be competitive and to use Mathematics and Science as vehicles for industrial growth. Botswana remains committed to improving qualitative aspect of the educational attainment to supplement the quantitative success that has been scored in sending children to school. Both RNPE and Vision 2016 advocate for the improvement in the quality of learning. Pursuant to recommendation 17b, Revised National Policy on Education (RNPE), 1994, p. 17), TIMSS is viewed as one project used for monitoring performance of education. Information obtained from TIMSS is used for informing curricula reviews and planning and implementing educational initiatives. Comparing the performance of Botswana students with the best around the world is a challenge that the country proudly undertakes because it provides the direction for channelling efforts into making Botswana a competitive country in the global economy.

How the Study was conducted

The initial effort on TIMSS 2011 was devoted to analysing the commonality between the TIMSS frameworks and the Botswana Form I curriculum. A country is not supposed to participate if its curriculum covers less than 70% of the frameworks. The frameworks are a compromise among participating countries and they fit no particular country perfectly. Items were then constructed to cover the Mathematics and Science contents defined by the frameworks. Questionnaire items were constructed to elicit background information from students, teachers, School Heads and parents.

Altogether, 25 schools participated in the pilot test. Two classes were sampled from each school to participate in the study. For the main survey, 150 schools participated and, from each school, one class was sampled to complete the instruments. Therefore, 150 School Heads responded to the research instruments. A school coordinator was appointed by each sampled school, and these coordinators were trained on their study roles. The names of the students in the sampled classes were obtained and captured into a database.

It is essential for an international study like TIMSS that the procedures be highly standardised. Therefore, Botswana teachers were trained on how to administer both the pilot and final data collection instruments. Teachers were used as coders and they were also trained in the procedure TIMSS uses for scoring the work of learners. Botswana coders were mostly teachers from the Junior Secondary Schools.

A great deal of effort was expanded on data capturing, which was manual. The captured data were transmitted to the TIMSS's Data Processing and Research Centre (DPC) for cleaning and verification. After data cleaning, scoring and scaling, countries were then able to carry out their analysis and write reports. IEA uses International database Analyser (IDB Analyser), which participating countries use for data analysis.

Major Findings

Performance of Botswana Students

Botswana students scored 396.68 in Mathematics and 404.44 in Science, both of which were below the TIMSS scale average of 500. Despite Botswana's participation at a higher grade of Form Two, out of 45 countries it was ranked third from the bottom in both Mathematics and Science.

Twenty-seven countries assessing eighth grade and the other three assessing their ninth grade students in mathematics had an average achievement below the scale average of 500. In Science, twenty-four countries assessing Form One and three assessing Form Two had an average achievement below the scale average of 500. Only 50% of Botswana students reached the international low benchmark in Mathematics and 55% in Science. It is evident that 50% of the students in Mathematics and 45% in Science failed to even reach the low benchmark. This is in comparison to 99% of the Koreans who reached the low benchmark in Mathematics, and 96% of the Singaporean who reached the low benchmark in Science. Students' performance in the content domains was the same in both subjects irrespective of when the content was taught. Girls performed better than boys overall, in both content and cognitive domains in both subjects.

Students' performance by background variables

Students' performance is not only dependent on the resources and quality of instruction. Background variables also play an important role in explaining their performance. A number of student, school, teacher and parent background variables were investigated.

(i) Students' background variables

Student's variables were such as the number of books at home, home possessions, home support, bullying at school, and age. Teacher's background variables were such as sex, age, educational qualification, teachers' professional attitudes, teachers' security and safety in school, teachers' motivation, teachers' confidence, and teachers' pedagogical strategies, among others. School background factors were: school size, proportion of students speaking English as native language, school location, instruction time, resources, parental involvement in school activities, school climate, and school leadership, while parent background factors were: relationship with the child, marital status, family size, language spoken at home, parents educational level, socio-economic status, and parental involvement in school work, among others. It was found that the availability of desirable factors or the absence of undesirable factors was associated with students' performance. However, the regression model shows that providing the best conditions for Botswana students will result in higher achievement scores of 420.16 and 438.56 for Science and Mathematics, respectively. However, these scores are still lower than the scale average of 500.

(ii) Teacher background variables

Teacher background variables were such as age, educational qualification, experience, gender, motivation, work environment, school facilities, professional attitudes and behaviour, enthusiasm, interaction with parents, assessment strategies, pedagogical strategies, content coverage, lesson preparation, and homework assignment, among others.

Generally most students were taught by teachers who had at least degree qualification in education. However, experience was found to be of paramount importance in performance of students. Older and more experienced teachers were not only acting as classroom teachers but as parents as well whom students could trust and rely on. Teacher's professional attitudes, behaviours, expectations and practices were important features in the delivery of instruction and imparting knowledge to the students, and consequently their performance. Schools were physically in a bad state for learning, with little or no resources. Generally, teachers were demotivated by the work conditions prevailing in schools which affected instruction and their ability to motivate students. Schools were to some extent, still a safer environment for teachers, although there was a growing trend of disorderly and disrespectful behaviour by some students.

Teachers training on pedagogical instruction were not enough as evidenced by their inability to use various learning and assessment strategies. Classroom tests were dominated by recall kind of questions with little emphasis on abstract reasoning. Despite that, teachers received little professional assistance from in-service department. Teachers' interaction with the parents was limited, as the schools consultation with parents about issues concerning students and schools was not treated as an integral component of the school programme. Generally lack of resources, lack of participation in professional development, lack of confidence and preparedness to teach certain content domains hampered teacher efficiency and effectiveness, consequently affecting students' performance.

(iii) School background variables

Schools differed in sizes ranging from small to big ones. Majority of schools had more students who came from poor families and such students performed unsatisfactorily. Although the language of instruction is English from Standard Two, majority of students spoke other languages other than English.

Resources, from school heads point of view were in short supply, including computers which have become the effective modern instructional gadget. However, schools which computers had seemed not to use them for educational purposes since their students' scores were not in any way different from those who did not have. According to the school heads, teachers had moderate to high job satisfaction; and they understood the curricula well, with high degree of implementation success. There was no collaboration as teachers never carried peer review and schools inspectors hardly observed them.

Schools were permeated with undesirable problem behaviours such as absenteeism, vandalism, theft, intimidation or verbal abuse, among others which are not conducive for learning. Likewise, teachers too showed problem behaviours which could also affect students' performance, such as late coming or leaving early, and absenteeism. These could be precursors for teacher demotivation or dissatisfaction of their working conditions.

(iv) Parent background variables

According to guardians, learners engaged in non-formal pre-school activities like numeracy and literacy, as evidenced by children's high literacy rate (92.0%) and some arithmetic competence when they started school. It was found that non-formal pre-school activities were positively associated with performance. Pre-schooling attendance is not compulsory in Botswana, as such only slightly less than half (46.43%) of the children had attended pre-schooling, and such children scored higher marks, However, parents who did not have the means to send their children to pre-primary formal set-up, continued with informal teaching of their children at home. About 9% of the students started schooling at the right age of five years or younger. At least 94% of Botswana children started school when they were 7 years or younger, as per the policy requirement and they performed better than those who started at a later age. However, either early schooling or the number of years spent in pre-school was also of paramount importance in the child learning and performance.

Students stayed with guardians as young as 20 years. Guardians included fathers, mothers, relative, and non-related guardian. Mothers constituted the highest proportion (62.3%) of the guardians and their educational background was higher than those of fathers. However, majority of the mothers were single parents. Nevertheless, the type of guardian was not positively correlated with performance. Children staying in small families tended to perform better possibly because more money was spent on their educational needs compared to those staying in large families. Majority of children spoke their mother tongue at home but those who spoke English scored better. Despite high proportion of parents with low levels of education, their expectation of children achieving higher levels of education was high.

Overall, students' parents were of middle income status. Families of medium to high level socio economic status possessed amenities and gadgets necessary for their children's learning. They also spent more money on their children's education. Children from well-to-do families with all the supporting facilities coupled with environment conducive for learning scored higher marks. There are still some children who stayed away from school due to lack of money to support their educational needs in terms of school fees, transportation, books, school uniform or any other need, despite widespread government social and financial networks to assist those who cannot afford.

The amount and quality of help that the child received was related to both the level of understanding of educational importance and the educational level of the parents. Children received help *regularly* and *sometimes* from the guardian they stayed with. Guardians and teachers collaboration was not satisfactory. Parents' participation in their children's education was optional. They chose when to participate and when not to even when called to discuss the children's progress or school work with teachers. Yet participation in ones child's education was positively associated with performance. Despite poor participation in their children's education, parents highly valued education.

It is well-known that children do not only learn at school, there is a lot of learning taking place at home as well. As such, parents involved their children in doing home chores as an extension to learning. Although home chores were important in the normal upbringing of children, it should not take much of the children's time of doing school work. Generally, children who were exposed to favourable learning environment such as better socio economic status, fewer family members, support from guardians, assistance with school work, high level valuing of education by parents, and high educational level of parents, tended to score higher in the tests.

CHAPTER ONE

INTRODUCTION

Trends in International Mathematics and Science Study (TIMSS)

An education system that is not assessed cannot lay claim to quality. Botswana takes assessment and evaluation as critical in attaining her objective of developing an educated and informed nation. The country does not only want to know how education is progressing, it is also interested in comparing its educational achievements with those of other countries around the world. For this reason, Botswana has joined an important international assessment body, the International Association for the Evaluation of Educational Achievement (IEA). IEA carries out a number of studies, one of which is the Trends in International Mathematics and Science Study (TIMSS).

TIMSS is a project aimed at assessing what students, at various stages of learning Mathematics and Science, know and are able to do. It is carried out by various countries around the world under the auspices of the IEA. The IEA is an independent international cooperative body of national assessment or research institutions of the participating countries. It was founded in 1959 for the purpose of conducting comparative research studies on educational policies, practices and outcomes.

TIMSS data collection is carried out every four years. Botswana participated for the first time in the third cycle of the study, in 2003, and has since participated in the subsequent cycles of 2007 and 2011. Southern Hemisphere countries collected the TIMSS 2011 data in October/December 2011 while the Northern Hemisphere countries collected the data in May 2011. Some countries carried out the study at Standard 4, besides Form I.

The Aims of TIMSS

The following constitute the major objectives of the TIMSS project:

- assessment of the level of Mathematics and Science learning of students
- identification of factors that impact on teaching and learning
- detection of trends in the learning achievement as well as in the education system
- comparison of achievement and teaching and learning conditions among the participating countries.

The purpose of carrying out the study is to provide policy makers, education managers, curriculum developers, teacher trainers, assessment bodies, researchers and all stakeholders with a rich source of information that can be used for the advancement of Science and Mathematics education. Information generated through TIMSS is intended to be used by educators to plan and execute activities that lead to improved learning of Mathematics and Science. Other than have one country believing that the standard of its Mathematics and Science education is high, an opportunity is given for each country to compare its standards with those of other countries. Basing the assessment on a common framework enables each country to diagnose the strengths and weaknesses in its Mathematics and Science curricula. These comparisons are very pertinent in a world that is quickly shrinking into a tiny village through digital and technological advances.

Contextual Background to the Study

The resolve of the Ministry of Education to use assessment as a means of monitoring and uplifting the quality of education can best be understood by taking a look at where the country intends to go. The Theme for National Development Plan, NDP 9 is: Towards Realisation of Vision 2016: Sustainable and Diversified Development through Competitiveness in Global Markets. Indeed Vision 2016 has become the cornerstone of Botswana's development. The relevant pillar for education in Vision 2016 is:

- An educated and informed nation

The task of producing an educated and informed nation falls directly under the Ministry of Education and Skills Development (MOESD). It is this Ministry that is called upon to produce the requisite manpower necessary for driving the economy forward.

The National Development Plan, NDP 10, adopts the theme of the accelerated achievement of the objectives of Vision 2016 and the Millennium Development Goals, through the enhancement of project implementation and improvement in service delivery in order to make the country more competitive internationally. That means that, the call on the Ministry of Education and Skills Development to avail the needed manpower is more urgent than ever before. In turn, the Ministry is tackling its tasks through a variety of approaches: teacher training, curricular review, with emphasis on the development of higher order thinking skills in the learner, work oriented training and putting emphasis on Mathematics, Science Engineering and entrepreneurial skills.

Given what education has to achieve, the need for monitoring becomes an imperative action. It is no longer just a matter of participating in TIMSS in fulfilment of the policy of continuous monitoring (REC.17b of the RNPE, 1994, p. 17), but indeed a check to see if the thrusts that had been put into the process of education and the activities associated with TIMSS 2003 and TIMSS 2007 reports had an impact. In other words, the 2011 cycle was meant to check if Botswana was becoming more and more competitive in accordance with its aspirations expressed in **Vision 2016** of being globally competitive with the best countries in the world.

TIMSS 2011, like its predecessors, offered countries an opportunity to assess either Standard Four or Form One, or both. Botswana opted for both. However, the pilot test results indicated that Botswana students did not reach most TIMSS items hence the reliability of the results would be questionable. As a result, the achievement tests were administered to Form Two's and Standard Six.

Conceptual Framework of the Study

Botswana's determination to utilise education to prepare the country to being progressive and technologically oriented is quite strong. This is reflected in the RNPE (1994, p.21) in a number of ways:

Among the accepted goals for the Junior Certificate curriculum are the following:

- o the capacity to use computational skills for practical purposes;
- o an understanding of scientific concepts and interest in the material world;

- an appreciation of technology and the acquisition of basic skills in handling tools and materials;
- computer literacy – each student is to take basic computer awareness course

  (Recommendation 32);

- critical thinking, problem-solving ability, individual initiative and interpersonal skills.

Having participated in TIMSS 2003 and 2007, there was a keen interest in finding out if the performance of Botswana students had improved even though the time for the interventions to have an impact was short. Not only was there an interest in finding out if the students' performance had improved, but the standing of the country in comparison to the other participating countries was expected to have improved. The concern that the nation had set itself a low benchmark by comparing itself with poor countries, rather than with the best in the world, was a driving force for moving forward with TIMSS 2007 and 2011.

Educational Structure of Botswana

Botswana operates a 7:3:2:4 system of education. Primary education takes seven years while junior secondary education lasts three years. Learners selected to go into senior secondary education take two years. In the same way, university education takes four years for most programmes.

Pupils take the Primary School Leaving Examination (PSLE) at the end of primary education. The PSLE results are used to provide diagnostic information intended to be used to improve the quality of teaching and learning. Virtually, every pupil taking the PSLE proceeds to Junior Secondary School, after which they sit the Junior Certificate Examination (JCE). The JCE is a selective examination for those proceeding to senior secondary level. The primary and junior secondary education levels form the ten-year Basic Education, and the intention is for every child to complete the Basic Education programme. After two years of senior secondary education, learners take the Botswana General Certificate of Secondary Education (BGCSE), the results of which are used for selection into tertiary institutions.

CHAPTER TWO

THE PROCESS OF THE STUDY

TIMSS Working Structures in Botswana

TIMSS is a large scale exercise that requires the involvement of a large number of people. Teachers, Examination Officers, Mathematics and Science Officers from the Ministry of Education and Skills Development (MOESD) were involved in the study. Professionals drawn from such institutions constituted the Working Team which had the mandate of scrutinising the TIMSS 2007 draft assessment frameworks.

The developed instruments must be administered. This made it necessary to identify and train staff for the administration of the instruments. During administration, it was necessary to check that the manual was adhered to. This was done by quality controllers, who were recruited and briefed thoroughly on their role. IEA engaged an International Quality Control Monitor while Botswana engaged National Quality Control Monitors. The responses of the students on the tests were coded by the teachers after undergoing training and they also provided information necessary for completing the curriculum questionnaire.

The Core team led by the TIMSS National Research Coordinator (NRC) carried out day-to-day operations of the project. The National Research Coordinator was the link with the IEA structures. The participating school appointed a school coordinator to handle most of the study activities at the school level. These school coordinators were also trained on their project roles. All communications on the project were subsequently directed to the attention of the School Coordinator.

Sampling for the TIMSS Project

Botswana's target population for the 2011 study was Form Two students. These are students who had nine years of schooling. Botswana, Ghana, and Honduras participated at Form Two level while the rest of the world used the Form One. This was because the pilot results had indicated that the Form One students were scoring too low which introduced a lot of measurement error in the international and respective country results. IEA dully advised that these three countries should use students from a higher grade. The names of all Junior Secondary Schools and Private English Medium schools in the country were obtained from the Department of Planning and Research Services (DPRES) of the Ministry of Education. A form was designed and sent to all these schools to indicate the district and inspectoral region of the school, whether the school is in an urban or rural location, ownership of the school, the total number of students each school had for Form Two and the number of classes (streams) in Form Two.

The sampling frame was sent to Statistics Canada, which was responsible for handling sampling for IEA. Sampling was multi-stage, stratified cluster, with the probability of being sampled proportional to the school size. Statistics Canada used software designed for this purpose and sampled 25 schools for piloting and 150 schools for the main data collection. The number of students in the main data collection was about 6000. Two classes were randomly selected in each school for pilot, while for the main survey only one class was selected at random.

The School Coordinator was then requested to list the students in each class that was selected. The names of these students were entered into the database, assigning each student a unique ID using the software supplied by Statistics Canada.

Defining the Assessment Frameworks

For a country to participate in IEA studies, its syllabus in the school system should march that of the IEA international framework by about 70%. Countries discuss and agree on these international frameworks as the basis for assessing achievement. IEA sends these frameworks to participating countries for discussion and comments at the national level. The Frameworks are sent with questionnaires eliciting country responses on the content and cognitive dimensions that should be assessed. The 2007 objectives were also listed and countries were to indicate against each objective whether it should be retained or dropped for the 2011 assessment. Countries were also asked to suggest new objectives that should be included.

The responses from countries were sent to the International Study Centre at Boston College. They then involved expert panels to scrutinise country responses in order to come up with revised frameworks for 2011. The revised draft was then circulated to countries for their comments before the final version was produced. It is necessary to involve experts and countries at various stages of frameworks development to ensure that what is going to be assessed is appropriate and important. New trends in curricula have to be captured.

Target percentages of TIMSS 2011 Mathematics and Science Assessment devoted to Content domains

Content Domains	Percentages
Mathematics	
Number	30
Algebra	30
Geometry	20
Data and Chance	20
Science	
Biology	35
Chemistry	20
Physics	25
Earth Science	20

Proportion of Mathematics and Science Cognitive Domains for assessments

Cognitive Domains	Percentages	
	Mathematics	Science
Knowing	35	35
Applying	40	35
Reasoning	25	30

Source: TIMSS 2011 Assessment Frameworks, Mullis et al TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College

The percentages reflect the perceived emphasis put on the content and cognitive dimensions in most of the participating countries.

International Benchmarks

The scale of achievement used by TIMSS gives a summary of performance of students on a test that is designed to measure the achievement of students of wide ability ranges. To make sense of what performance on such a scale means, TIMSS identified four points on the scale and used them as benchmarks. Items that students at each benchmark are likely to answer correctly are then used to describe the students' knowledge and understanding at that benchmark. This exercise is called scale anchoring. The four benchmarks identified for each subject are low, medium, high and advanced. The brief descriptions of these anchors are given in Table 2.1 below with an extended description of each benchmark.

Table 2.1: Overview of TIMSS 2011 International Benchmarks

Benchmark	***Score level***	***Description of benchmarks***	
		Mathematics	*Science*
Advanced	*625*	*Reason, draw conclusions, make generalizations, and solve linear equations*	*Communicate an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science.*
High	*550*	*Apply knowledge and understanding in a variety of relatively complex situations.*	*Demonstrate understanding of concepts related to science cycles, systems, and principles.*
Intermediate	*475*	*Apply basic knowledge in a variety of situations.*	*Apply understanding of basic scientific knowledge in various contexts.*
Low	*400*	*Some knowledge of whole numbers and decimals, operations, and basic graphs.*	*Recognize some basic facts from the life and physical sciences.*

TIMSS 2011 International Benchmarks of Mathematics Achievement

Advanced International Benchmark - 625
Students can organise and draw conclusions from information, make generalisations, and solve non-routine problems. They can solve a variety of ratio, proportion and percent problems. They can apply their knowledge of numeric and algebraic concepts and relationships. Students can express generalisations algebraically and model situations. They can apply their knowledge of geometry in complex problem situations. Students can derive and use data from several sources to solve multi-step problems.

High International Benchmark - 550
Students can apply their understanding and knowledge in a variety of relatively complex situations. They can relate and compute with fractions, decimals, and percentages operate with negative integers, and solve word problems involving proportions. Students can work with algebraic expressions and linear equations. Students use knowledge of geometric properties to solve problems, including area, volume, and angles. They can interpret data in a variety of graphs and tables and solve simple problems involving probability.

Intermediate International Benchmark - 475
Students can apply basic mathematical knowledge in straightforward situations. They can add and multiply to solve one-step word problems involving whole numbers and decimals. They can work with familiar fractions. They understand simple algebraic relationships. They demonstrate understanding of properties of triangles and basic geometric concepts. They can read and interpret graphs and tables. They recognise basic notions of likelihood.

Low International Benchmark – 400
Students have some knowledge of whole numbers and decimals, operations, and basic graphs.

TIMSS 2011 International Benchmarks of Science Achievement

Advanced International Benchmark – 625
Students demonstrate a grasp of some complex and abstract concepts in Biology, Chemistry, Physics, and Earth Science. They have an understanding of the complexity of living organisms and how they relate to their environment. They show understanding of the properties of magnets, sound, and light, as well as demonstrating understanding of structure of matter, physical and chemical properties and changes. Students apply knowledge of the solar system and of Earth's features and processes, and apply understanding of major environmental issues. They understand some fundamentals of scientific investigation and can apply basic physical principles to solve some quantitative problems. They can provide written explanations to communicate scientific knowledge.

High International Benchmark – 550
Students demonstrate conceptual understanding of some Science cycles, systems, and principles. They have some understanding of biological concepts including cell processes, human biology and health, and the interrelationship of plants and animals in ecosystems. They apply knowledge to situations related to light and sound, demonstrate elementary knowledge of heat and forces, and show some evidence of understanding the structure of matter, and chemical and physical properties and changes. They demonstrate some understanding of the solar system, Earth's processes and resources, and some basic understanding of major environmental issues. Students demonstrate some scientific inquiry skills. They combine information to draw conclusions, interpret tabular and graphical information, and provide short explanations conveying scientific knowledge.

Intermediate International Benchmark – 475
Students recognise and communicate basic scientific knowledge across a range of topics. They demonstrate some understanding of characteristics of animals, food webs, and the effect of population changes in ecosystems. They are acquainted with some aspects of sound and force and have elementary knowledge of chemical change. They demonstrate elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students extract information from tables and interpret pictorial diagrams. They can apply knowledge to practical situations and communicate their knowledge through brief descriptive responses.

Low International Benchmarks- 400
Students recognise some basic facts from the life and physical Sciences. They have some knowledge of the human body and demonstrate some familiarity with everyday physical phenomena. Students can interpret pictorial diagrams and apply knowledge of simple physical concepts to practical situations.

TIMSS 2011 Student Booklet Design

A major consequence of TIMSS' ambitious reporting goals is that many more questions are required for the assessment than can be answered by any one student in the amount of testing time available. Accordingly, TIMSS 2011 used a matrix-sampling approach that involved packaging the entire assessment pool of Mathematics and Science items at each Standard level into a set of 14 student achievement booklets, with each student completing just one booklet. Each item appears in two booklets, providing a mechanism for linking together the student responses from the various booklets. Booklets are distributed among students in participating classrooms so that the groups of students completing each booklet are approximately equivalent in terms of student ability. TIMSS uses item-response theory scaling methods to assemble a comprehensive picture of the achievement of the entire student population from the combined responses of individual students to the booklets that they are assigned. This approach reduces to manageable proportions what otherwise would be an impossible student burden, albeit at the cost of greater complexity in booklet assembly, data collection, and data analysis.

To facilitate the process of creating the student achievement booklets, TIMSS groups the assessment items into a series of item blocks, with approximately 10-14 items in each block at the fourth Standard and 12-18 at the eighth Standard. As far as possible, within each block the distribution of items across content and cognitive domains matches the distribution across the item pool overall. As in the TIMSS 2007 assessment, TIMSS 2011 has a total of 28 blocks, 14 containing Mathematics items and 14 containing Science items. Student booklets were assembled from various combinations of these item blocks.

Following the 2007 assessment, 8 of the 14 Mathematics blocks and 8 of the 14 Science blocks were secured for use in measuring trends in 2011. The remaining 12 blocks (6 Mathematics and 6 Science) were released into the public domain for use in publications, research, and teaching, to be replaced by newly-developed items for the TIMSS 2011 assessment. Accordingly, the 28 blocks in the TIMSS 2011 assessment comprise 16 blocks of trend items (8 Mathematics and 8 Science) and 12 blocks of new items developed for 2011. As shown in Exhibit 10, the TIMSS 2011 Mathematics blocks are labelled M01 through M14 and the Science blocks S01 through S14. Blocks with labels ending in odd numbers (01, 03, 05, etc.) contain the trend items from the 2007 assessment, as do blocks ending in 06. The remaining blocks with labels ending in even numbers contain the items developed for use for the first time in TIMSS 2011.

Exhibit 10: TIMSS 2011 Item Blocks – Fourth and Eighth Grades

Mathematics Blocks	Source of Items	Science Blocks	Source of Items
M01	Block M13 from TIMSS 2007	S01	Block S13 from TIMSS 2007
M02	New items for TIMSS 2011	S02	New items for TIMSS 2011
M03	Block M06 from TIMSS 2007	S03	Block S06 from TIMSS 2007
M04	New items for TIMSS 2011	S04	New items for TIMSS 2011
M05	Block M09 from TIMSS 2007	S05	Block S09 from TIMSS 2007
M06	Block M10 from TIMSS 2007	S06	Block S10 from TIMSS 2007
M07	Block M11 from TIMSS 2007	S07	Block S11 from TIMSS 2007
M08	New items for TIMSS 2011	S08	New items for TIMSS 2011
M09	Block M08 from TIMSS 2007	S09	Block S08 from TIMSS 2007
M10	New items for TIMSS 2011	S10	New items for TIMSS 2011
M11	Block M12 from TIMSS 2007	S11	Block S12 from TIMSS 2007
M12	New items for TIMSS 2011	S12	New items for TIMSS 2011
M13	Block M14 from TIMSS 2007	S13	Block S14 from TIMSS 2007
M14	New items for TIMSS 2011	S14	New items for TIMSS 2011

Source: TIMSS 2011 Assessment Frameworks, Mullis et al TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.

In choosing how to distribute assessment blocks across student achievement booklets, the major goal was to maximize coverage of the framework while ensuring that every student responded to sufficient items to provide reliable measurement of trends in both Mathematics and Science. A further goal was to ensure that achievement in the Mathematics and Science content and cognitive domains could be measured reliably. To enable linking among booklets while keeping the number of booklets to a minimum, each block appears in two booklets.

In the TIMSS 2011 booklet design, the 28 assessment blocks are distributed across 14 student achievement booklets (see Exhibit 11). Each student booklet consists of four blocks of items; two blocks of Mathematics items and two blocks of Science items. In half of the booklets, the two Mathematics blocks come first, followed by the two Science blocks, while in the other half the order is reversed. Additionally, in most booklets two of the blocks contain trend items from 2007 and two contain items newly developed for TIMSS 2011.

Exhibit 11: TIMSS 2011 Student Achievement Booklet Design – Fourth and Eighth Grades

Student Achievement Booklet	Assessment Blocks			
	Part 1		Part 2	
Booklet 1	M01	M02	S01	S02
Booklet 2	S02	S03	M02	M03
Booklet 3	M03	M04	S03	S04
Booklet 4	S04	S05	M04	M05
Booklet 5	M05	M06	S05	S06
Booklet 6	S06	S07	M06	M07
Booklet 7	M07	M08	S07	S08
Booklet 8	S08	S09	M08	M09
Booklet 9	M09	M10	S09	S10
Booklet 10	S10	S11	M10	M11
Booklet 11	M11	M12	S11	S12
Booklet 12	S12	S13	M12	M13
Booklet 13	M13	M14	S13	S14
Booklet 14	S14	S01	M14	M01

Source: TIMSS 2011 Assessment Frameworks, Mullis et al TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.

Development of the Instruments

IEA releases some items from time to time which have to be replaced. One of the National Research Coordinators' meetings was used for the construction of items, and Botswana sent two experts in Mathematics and Science to take part.

As for the 2011 assessment, items were of the select-format as well as problem-solving in an open-ended format. IEA aims at putting more emphasis on questions and tasks that offer better insight into the analytical, problem-solving and inquiry skills of students. More investigative and production-based tasks were advocated for in order to be able to cater for the cognitive domains that had been identified.

After compiling the test booklets, each country had to go through cultural adaptation of the items. This involved checking the items as presented to see if there was any cultural aspect in the items that would make it unsuitable for the intended population in a country. In such a case, a country was required to propose an amendment to that particular item that would solve the cultural concern at hand without changing the nature of the task in any way. These suggestions were then sent to IEA Headquarters in Amsterdam. The IEA secretariat appointed an independent verifier of the cultural adaptations for each country and where this verifier did not agree with the suggestions; the proposed changes could not be made. This tight control had to be maintained to ensure that countries around the world would be administering the same items.

The process of cultural adaptation included the translation from English to the language of instruction in countries that do not use English as a medium of instruction. Countries that needed to translate the tests from English to the language of instruction had to go through the verifier to make sure that the translated items were the same as the original ones in English. Botswana made slight changes during the process of translation as its language of instruction is English.

Background questionnaires were developed for School Heads, Mathematics and Science teachers, and for the students. The piloting of the questionnaires was done at the same time with that of the Mathematics and Science items. Botswana used the 2007 parent questionnaire which it developed specifically for local use. The questionnaires were similarly subjected to cultural adaptation and translation as were the achievement items.

Piloting the Instruments

The pilot data collection in Botswana was based on Form Two students. This is because piloting was carried out in March-April 2010 and by that time Form One students had covered very little of their curriculum as the school year begins in January. The items targeted students who had completed eight years of education (students completing Form One). The TIMSS 2011 used the Form Two for both the pilot and the main survey. Test administration followed and adhered to the detailed procedure as documented in the Administration manual. This was necessary for standardisation of the procedures in all the schools and in every participating country. Administrators who were mainly retired teachers were trained on the administration procedures.

The exercise basically involved informing the schools when the instruments would be administered in their schools, and requesting the School Coordinator to prepare a hall where the tests would be administered. Upon reporting to the School Head, the test administrators were taken to the School Coordinator who, in turn, took them to the test hall. The test administrators gave the correct booklet labelled with the student's identification particulars. In case a booklet was spoilt or torn, there was a procedure to follow on how to replace it. Each test booklet had two parts which were independently sealed so that while working on part one, students had no access to part two. After a short break students would return for part two, followed by the completion of the student questionnaire. While all these were going on, the School Head, Mathematics and Science teachers were busy completing their respective questionnaires.

Open-ended responses needed to be scored (coded). Thus country representatives were trained in the diagnostic coding procedure that IEA uses for TIMSS. The Botswana National Research Coordinator and another Core Team member, who were trained by IEA trained colleagues, and selected teachers from Junior Secondary Schools, then coded the responses of the students included in the pilot sample. A sample of the scripts had to be coded by two coders each for checking on the extent of reliability of the coding exercise. Temporary research assistants were also recruited to assist with data capturing as there was massive data to be captured. The pilot data were then sent to IEA's Data Processing Centre in Hamburg, Germany. The pooled responses from piloting countries were analysed to check on how the items functioned at the pilot stage. A National Research Coordinators' workshop was convened to discuss and decide on the piloted items to be included in the 2011 assessment.

The Test Booklets for Final Data Collection

There were 14 booklets used for the final data collection. Like in the pilot, each booklet contained both Mathematics and Science items. The old and newly developed items were arranged into mutually exclusive blocks of Mathematics and Science. The estimated time for completion of each block was 15 minutes, even though the numbers of items in the blocks were not the same. Each block was systematically assigned between two to four test booklets.

Each test booklet had two parts and each part was separately sealed so that a student working on one part could not read the items for the other part. Each part had to be completed in 45 minutes.

Background Questionnaires

Just like TIMSS 2007, TIMSS 2011 had five questionnaires: student questionnaire, teacher questionnaire (one for Mathematics teacher and another for Science teacher), school questionnaire and curriculum questionnaire. Botswana opted for an additional parent questionnaire. The student questionnaire elicited background information from students, including study their aspirations and attitudes towards Mathematics and Science. The teacher questionnaire was separated into Mathematics teacher questionnaire and Science teacher questionnaire. This questionnaire sought information from the teacher as to the curriculum that was actually implemented at classroom level, the academic and professional background of the teacher, their instructional practices and attitudes towards the subject. The School head was requested to provide background information of the school, such as enrolment, teachers, facilities, etc. The curriculum questionnaire sought national views on the objectives in the frameworks as to whether they were in the curriculum. The parent questionnaire sought the background information from the parents relating to the education of their child.

Main Survey Data Collection

The process of data collection for the main survey was the same as the pilot data collection. The same officers who participated in the pilot data collection were reinforced with newly trained test administrators (teachers) so as to be able to cover the all schools within the programmed two weeks. The final instruments were administered to Form One students in October-November, 2010. Though the TIMSS project was for 2011, Southern Hemisphere countries had to collect their data earlier while Northern Hemisphere countries had to collect theirs in May/June 2011 when their school year ended.

The data collection schedule was sent to the sampled schools for the main data collection. Instruments and other documents required for each school were printed and packed. The test booklet for each student was labelled with his/her name and identity number. As at the pilot stage, the administrators had to strictly adhere to the scripts in the administration manual.

One expert in assessment was identified and sent to Amsterdam to train as an international quality control monitor. This officer was fully supported by IEA during the data collection to ensure that there was minimal contact between him and the project team. His report indicated great adherence to the administration procedures. Three other Quality Control Monitors were trained by the National Research Coordinator (NRC) and supported by the project funds. The idea was to increase coverage of the testing centres as recommended by IEA. Indeed, most of the centres were visited and these National

Quality Control Monitors came back with very impressive reports on how the test administrators handled their work.

The teachers and officers who coded the pilot scripts were engaged in coding the open-ended responses for the main survey. As in the pilot sample, some of the scripts were double-coded for assessing the reliability of the coding exercise. These reliability scripts were eventually sent to DPC at Hamburg for scanning so that the scripts could be available for future coding.

The curriculum questionnaire was responded to by the coders under the leadership of a curriculum development officer as they constituted the body of practitioners who knew what was in the curriculum up to Form One level of education. Responses were then transmitted to DPC online.

Data Capture and Cleaning

More temporary data capturing assistants were engaged in capturing data in addition to those who captured for the pilot. Data was subsequently sent to DPC. Throughout the study, IEA took measures to enhance the quality of the data collected from each country. A booklet was produced to give guidance on data entry so that the structure of the data was the same from country to country. Once received, DPC went through extensive data cleaning procedures, and corresponded with NRCs to clear emerging queries. Considering the massive data captured, Botswana data were relatively clean and there were no major concerns raised by the DPC.

Data Analysis and Report Writing

The data from DPC scored students' responses and the development of the scales for reporting. Item Response Theory (IRT) models were used for item and persons' parameter estimates. The three-parameter model was used for multiple-choice items scored correct/incorrect; the two-parameter model was used for free-response items scored correct/incorrect and the partial credit model was used for polytomous free-response items with two or more score points. IRT allows the performance of students to be summarised on a common metric or scale even though individual students did not respond to the same items. A scale average was set at 500 (as the mean) and a standard deviation of 100. Rather than a single value of ability estimate for each student on each scale, plausible values were generated and five of these were used for obtaining mean values for specified groups.

Because of lack of random sampling and the use of plausible values, SPSS could not be used directly for obtaining mean values and percentages. IEA studies use SPSS sitting on the International database Analyser (IDB Analyser) platform.

Interpretation of Results

(a) Means, standard error and significant differences

The results are mostly presented in tables indicating percentages and means of students in various groups; the standard errors of these percentages and means. Where subgroups are compared, mean differences and the standard error of the mean differences are reported. Standard errors indicate the extent of the accuracy of an estimation of the mean or mean difference. An example is presented in Table 2.2.

Table 2.2: *Performances by Number of Books in the Home*

# of books	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
0-10	1,639	40.46	405.39 (3.86)	83.43	1,2:-26.26	342.52 (5.39)	121.11	1,2:-42.98
11-25	1,360	33.47	431.65 (3.35)	82.55	1.3:-40.37	385.50 (5.44	122.29	1,3:-70.90
26-100	662	16.52	445.76 (6.94)	92.48	2,3: -15.11	413.42 (9.60)	134.84	2,3:-27.92

**Statistically significant at 5% level*

The *n* is the number of students in each category and the percentage they constitute. The Mathematics mean score of 405.39 with a standard error of 3.86 means that the mean could be between 401.53 and 409.25. Mean differences (**Diff)** is used throughout this report for checking whether subgroup differences are significant. In the example above, interest centres on finding out if there are significant differences in the performance of students who come from homes with different numbers of books. Is the difference in the Science performance of students from homes with *0-10 books* and students from homes with *11-25 books* statistically significant? This question is answered by looking under the column of **Diff** for Science.

The first row in this column starts with '1,2'. This means that the mean difference being considered is for the means of rows one and two. Under Science, row one mean is 342.52 and row two mean is 385.50. The difference between the two means is -42.98. A significant mean difference (Diff) is indicated by an asterisks (*).

b) *Regression Analysis*

In some instances, a complex model is required in order to estimate the effect of one or more variables on performance. The analysis of the TIMSS data was complex in nature because there were interrelationships between the students' achievements and contextual factors, including students' background variables. In most cases, estimating the mean performance of students without taking into account this unique relationship between variables may result in misleading outcomes. Thus, the regression model which aims to relate the dependent variable and independent variable(s) was used. The essence of regression analysis is to predict the effect of one factor on the dependent variable in the presence of other factors which may have a different effect on the same variable.

Technically, the interpretation of the effect of one variable on the dependent variable, in the presence of other factors, is considered as estimating the effect of one factor on the outcome, when other factors are kept constant or controlling for other factors. This is the terminology used in the analysis of TIMSS data. The flexibility of regression analysis allows for the use different variables of varying measurement scales for example, the ratio scale, the ordinal, nominal or interval as independent variables. But, the dependent variables need to be continuous in nature, for example, the students' achievement scores. In order to aid the readers to understand the regression analysis outcome in this report, a simple example on regression analysis is interpreted below:

Table 2.3: *Regression Analysis*

Variables	Coefficients	Standard Error (SE)	t-Value
Constant	497.44	10.96	45.37
Age	-24.96	2.08	-11.99*
Sex			
Male	-5.05	3.72	-1.36
Home Possession			
Low	-49.64	7.1	-6.99*
Medium	-29.51	5.01	-5.89*
Number of Books at Home			
0--10 Books	-17.07	8.85	-1.93
11--25 Books	-11.54	8.29	-1.39
26--100 Books	-5.09	8.88	-0.57

**Statistically significant at 5% level*

The table above shows four variables in the model, namely; *Age, Sex, Home possession* and *Number of books*. All these variables except *Age* are categorical in nature. *Age* is continuous and, it has been centred on the mean age of the group so that the intercept of the model translates to the overall mean score of the student. The coefficient for *Age* is -24.96. This value suggests that a student who is one year older than the *mean Age* of the student being studied will score on average 24.96 points lower than a student at the *mean Age*.

Sex has two categories; *Male* and *Female.* The *Female* category is used as a reference point for comparison with the *Male* category. For instance the coefficient -5.05 means that *Male* students scored 5 points lower than the *Female* students, when taking into account the effect of other variables in the model.

Home possession has 3 levels, *High, Medium* and *Low*. The category *High is a* reference for comparison with other categories of this variable. For example, the coefficient of -49.64 for *Low* means that a student who came from a household with home possession regarded as *Low* scored 49.64 points lower than the student who came from a household with home possession regarded as *High*. For a *Medium* household, the difference is -29.51.

For the variable Number of Books at home, the reference level is *"100 or more books at home".* All the levels are contrasted to this level. The difference between students with *0-10 books at home* and those with *100 or more books at home is -17.07,* suggesting that students who have *0-10 books at home* will score 17.07 points lower on average compared to those with *100 or more books at home.* For the category *11-25 books at home,* the difference is -11.54 and, it is -5.09 for students with *26-100 books at home.*

The Constant term in the model represents the mean performance of students who have characteristics similar to the reference level in each variable. For instance, 497.44 means that a *Female* whose age is around the mean *Age* of the students studied, came from a household with home possessions considered as *High*, with a *100 or more books at home,* will score on average, 497.44 points. The t-value indicates statistical significance at 5% level for a two-tailed test. A t-value of -11.99* indicates that older students achieved significantly lower than their younger ones, and this is not due to chance occurrence.

(b) Indices

Questionnaires were made up of themes under which there were many items. The items were grouped together to form one or more constructs. An index was therefore obtained by calculating the mean response for an individual for that construct. Negatively worded items were reversed before analysis to align with the rest. Naming the construct was a mammoth task because the name given must be representative of the underlying construct. For better appreciation by the readers, an example on how an index was constructed is given below. An Index of *Frequency of parents support* is constructed from the following questions which were asked the students;

(1) My parents ask me what I am learning in school.
(2) I talk about my schoolwork with my parents.
(3) My parents make sure that I set aside time for my homework.
(4) My parents check if I do my homework.

The students had to indicate how often these things happen to them at home by responding: *Every day or Almost Every Day*; *Once or twice a week*; *Once or twice a month*; and, *Never or almost Never* for each question. Responses were coded 1, 2,3 & 4 respectively. The index is *constructed* by first computing the mean response of a student and then categorizing the mean into four categories *Every day or Almost Every Day*; *Once or twice week*; *Once or twice a month*; and, *Never or almost Never*. The frequency distribution of the mean response is displayed in Table 2.4 below. By so doing, only one variable with 4 responses is created. Forming categories of the Index is done by recoding the mean into 4 levels. Determining the threshold of the levels is arbitrary, for the *Frequency of parents support*, the cut points for *Every day or Almost Every Day* was 1.25; for *Once or twice week*, it was 2.25; for *Once or twice a month*, it was 3.25; and, for *Never or almost Never*, it was 4.

Table 2.4 *Frequency Distribution of the Mean Response*

Mean Response	Frequency	%	Frequency of parent support
1.00	1539	37.0	Every day or almost everyday
1.25	853	20.5	
1.33	7	.2	Once or twice a week
1.50	418	10.1	
1.67	9	.2	
1.75	401	9.7	
2.00	278	6.7	
2.25	164	3.9	
2.33	8	.2	Once or twice a month
2.50	203	4.9	
2.67	4	.1	
2.75	84	2.0	
3.00	65	1.6	
3.25	48	1.2	
3.50	26	.6	Never or almost never
3.75	16	.4	
4.00	32	.8	
Total	4155	100.0	

CHAPTER THREE

STUDENTS' ACHIEVEMENT

This chapter presents the performance of Botswana students in Mathematics and Science. Table 3.1 below shows students' performance in comparison with the previous cycles.

Table 3.1: *Performance of Botswana Students in Mathematics and Science compared to Previous Cycles*

Year	**n**	**%**	**Mathematics** Mean (SE)	**Science** Mean (SE)
2011	5,400	100	396.68 (2.50)	404.44 (3.57)
2007	4208	100	363.54(2.27)	354.53(3.05)
2003	5150	100	366.2(2.6)	364.6 (2.8)

Botswana students did not perform well in the achievement tests. They scored 397 in Mathematics and 404 in Science. In both subjects, their performance was about one standard deviation below the TIMSS scale average of 500, and more than two standard deviations below the best performing Countries (refer to Exhibit 1.2). It is evident that the performance of Botswana students has gone up a little compared to the 2007 and 2003 cycles. However, it should be noted that the 2011 cycle used Form Two students while the previous cycles used Form One students. The improved performance by Form Two's can be attributed to more knowledge acquisition and to some extent, maturity.

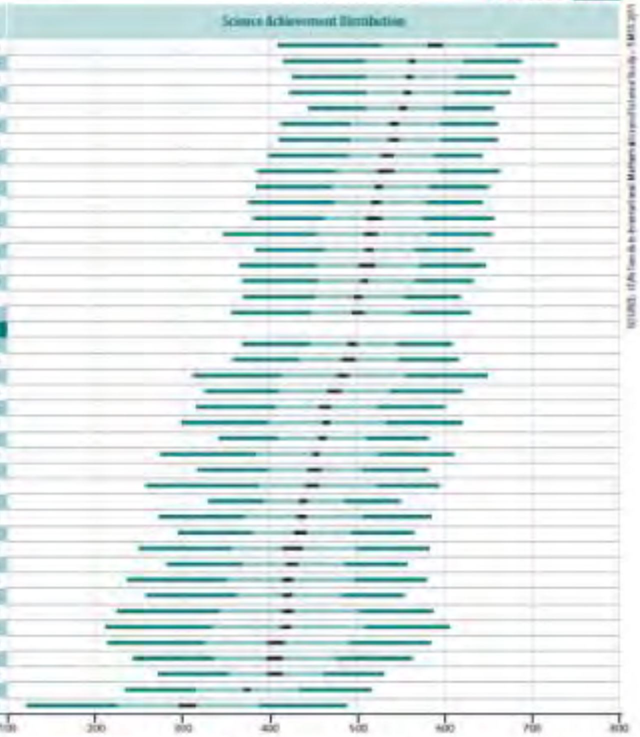
Performance of Botswana Students Compared to other Countries

The performance of Botswana students compared to those of other participating countries is shown in Exhibit 1.2, which has been adapted from the TIMSS 2011 International report.

Exhibit 1.2: Distribution of Science Achievement

TIMSS 2011 Science 8th Grade

Country	Average Scale Score	
† Singapore	590 (4.3)	▲
Chinese Taipei	564 (2.3)	▲
Korea, Rep. of	560 (2.0)	▲
Japan	558 (2.4)	▲
Finland	552 (2.5)	▲
Slovenia	543 (2.7)	▲
‡ Russian Federation	542 (3.2)	▲
Hong Kong SAR	535 (3.4)	▲
† England	533 (4.9)	▲
† United States	525 (2.6)	▲
Hungary	522 (3.1)	▲
Australia	519 (4.8)	▲
‡ Israel	516 (4.0)	▲
† Lithuania	514 (2.6)	▲
New Zealand	512 (4.6)	▲
Sweden	509 (2.5)	▲
Italy	501 (2.5)	
Ukraine	501 (3.4)	
TIMSS Scale Centerpoint	500	
Norway	494 (2.6)	▼
Kazakhstan	490 (4.3)	▼
Turkey	483 (3.4)	▼
Iran, Islamic Rep. of	474 (4.0)	▼
Romania	465 (3.5)	▼
United Arab Emirates	465 (2.4)	▼
Chile	461 (2.5)	▼
Bahrain	452 (2.0)	▼
Thailand	451 (3.9)	▼
Jordan	449 (4.0)	▼
Tunisia	439 (2.5)	▼
Armenia	437 (3.1)	▼
Saudi Arabia	436 (3.9)	▼
Malaysia	426 (6.3)	▼
Syrian Arab Republic	426 (3.9)	▼
Palestinian Nat'l Auth.	420 (3.2)	▼
²† Georgia	420 (3.0)	▼
Oman	420 (3.2)	▼
Qatar	419 (3.4)	▼
Macedonia, Rep. of	407 (5.4)	▼
Lebanon	406 (4.9)	▼
Indonesia	406 (4.5)	▼
Morocco	376 (2.2)	▼
Ψ Ghana	306 (5.2)	▼



▲ Country average significantly higher than the centerpoint of the TIMSS 8th grade scale

▼ Country average significantly lower than the centerpoint of the TIMSS 8th grade scale

Ψ Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%.
See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ≡.
( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Exhibit 1.2: Distribution of Science Achievement (Continued)

TIMSS 2011 Science 8th Grade

Country	Average Scale Score	
Ninth Grade Participants		
Botswana	404 (3.6)	▼
† Honduras	369 (4.0)	▼
Ψ South Africa	332 (3.7)	▼
Benchmarking Participants		
† ‡ Massachusetts, US	567 (5.1)	▲
† Minnesota, US	553 (4.6)	▲
‡ Alberta, Canada	546 (2.4)	▲
† Colorado, US	542 (4.4)	▲
† ‡ Indiana, US	533 (4.8)	▲
† ‡ Connecticut, US	532 (4.4)	▲
† ‡ North Carolina, US	532 (6.3)	▲
† ‡ Florida, US	530 (7.3)	▲
‡ Ontario, Canada	521 (2.5)	▲
Quebec, Canada	520 (2.5)	▲
† ‡ California, US	499 (4.6)	
† Alabama, US	485 (6.2)	▼
Dubai, UAE	485 (2.5)	▼
Abu Dhabi, UAE	461 (4.0)	▼

▲ Country average significantly higher than the centerpoint of the TIMSS 8th grade scale

▼ Country average significantly lower than the centerpoint of the TIMSS 8th grade scale

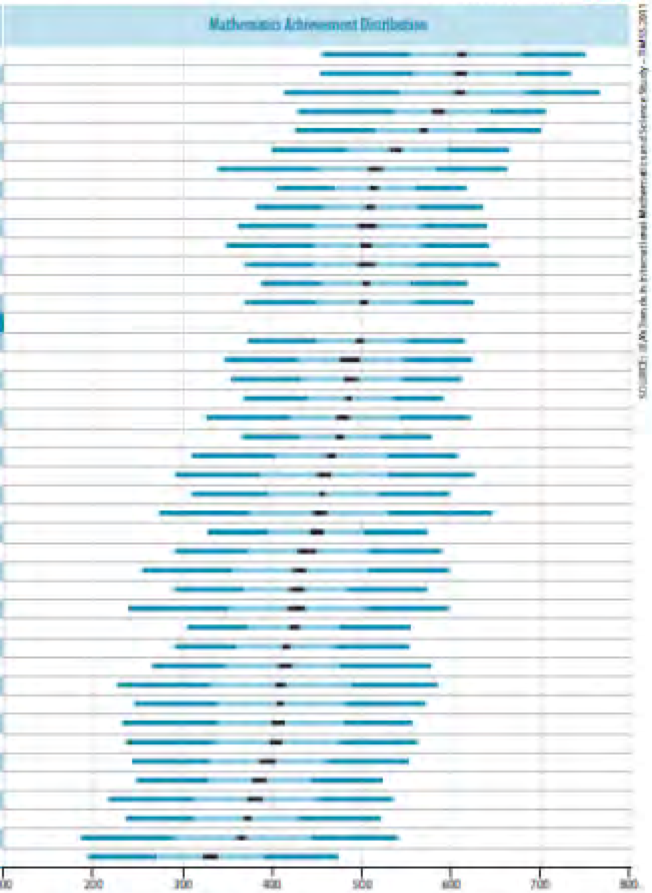
SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Exhibit 1.2: Distribution of Mathematics Achievement

TIMSS 2011 Mathematics 8th Grade

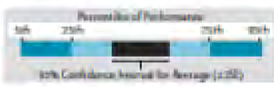
Country	Average Scale Score	
Korea, Rep. of	613 (2.9)	⊙
[2] Singapore	611 (3.8)	⊙
Chinese Taipei	609 (3.2)	⊙
Hong Kong SAR	586 (3.8)	⊙
Japan	570 (2.6)	⊙
[2] Russian Federation	539 (3.6)	⊙
[2] Israel	516 (4.1)	⊙
Finland	514 (2.5)	⊙
[2] United States	509 (2.6)	⊙
† England	507 (5.5)	
Hungary	505 (3.5)	
Australia	505 (5.1)	
Slovenia	505 (2.2)	⊙
[1] Lithuania	502 (2.5)	
TIMSS Scale Centerpoint	500	
Italy	498 (2.4)	
New Zealand	488 (5.5)	⊛
Kazakhstan	487 (4.0)	⊛
Sweden	484 (1.9)	⊛
Ukraine	479 (3.9)	⊛
Norway	475 (2.4)	⊛
Armenia	467 (2.7)	⊛
Romania	458 (4.0)	⊛
United Arab Emirates	456 (2.1)	⊛
Turkey	452 (3.9)	⊛
Lebanon	449 (3.7)	⊛
Malaysia	440 (5.4)	⊛
[1] Georgia	431 (3.8)	⊛
Thailand	427 (4.3)	⊛
Ψ Macedonia, Rep. of	426 (5.2)	⊛
Tunisia	425 (2.8)	⊛
Chile	416 (2.6)	⊛
Ψ Iran, Islamic Rep. of	415 (4.3)	⊛
Ψ Qatar	410 (3.1)	⊛
Ψ Bahrain	409 (2.0)	⊛
Ψ Jordan	406 (3.7)	⊛
Ψ Palestinian Nat'l Auth.	404 (3.5)	⊛
Ψ Saudi Arabia	394 (4.6)	⊛
Ψ Indonesia	386 (4.3)	⊛
Ψ Syrian Arab Republic	380 (4.5)	⊛
Ж Morocco	371 (2.0)	⊛
Ψ Oman	366 (2.8)	⊛
Ж Ghana	331 (4.3)	⊛

Mathematics Achievement Distribution



⊙ Country average significantly higher than the centerpoint of the TIMSS 8th grade scale

⊛ Country average significantly lower than the centerpoint of the TIMSS 8th grade scale



Ж Average achievement not reliably measured because the percentage of students with achievement too low for estimation exceeds 25%.

Ψ Reservations about reliability of average achievement because the percentage of students with achievement too low for estimation does not exceed 25% but exceeds 15%.

See Appendix C.3 for target population coverage notes 1, 2, and 3. See Appendix C.9 for sampling guidelines and sampling participation notes †, ‡, and ‡.

( ) Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

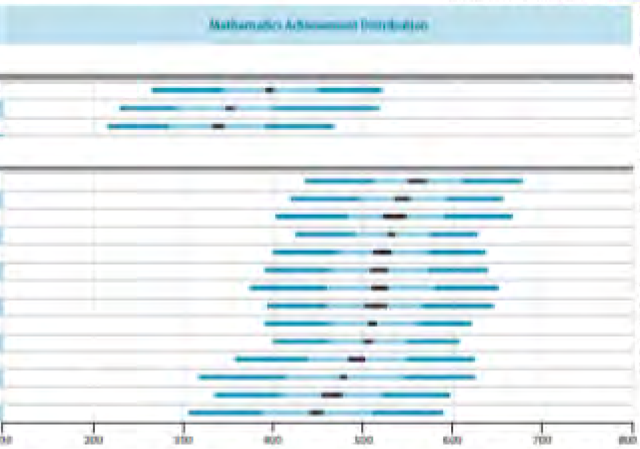
SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

Exhibit 1.2: Distribution of Mathematics Achievement (Continued)

TIMSS 2011 Mathematics 8th Grade

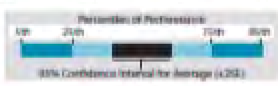
Country	Average Scale Score	
Ninth Grade Participants		
Ψ Botswana	397 (2.5)	⊛
Ж South Africa	352 (2.5)	⊛
‡ Ж Honduras	338 (3.7)	⊛
Benchmarking Participants		
[1] ‡ Massachusetts, US	561 (5.3)	⊙
[1] Minnesota, US	545 (4.6)	⊙
[1] ‡ North Carolina, US	537 (6.8)	⊙
Quebec, Canada	532 (2.3)	⊙
[1] ‡ Indiana, US	522 (5.1)	⊙
[1] Colorado, US	518 (4.9)	⊙
[1] ‡ Connecticut, US	518 (4.8)	⊙
[1] ‡ Florida, US	513 (6.4)	⊙
‡ Ontario, Canada	512 (2.5)	⊙
‡ Alberta, Canada	505 (2.6)	
[1] ‡ California, US	493 (4.9)	
Dubai, UAE	478 (2.1)	⊛
[1] Alabama, US	466 (5.9)	⊛
Abu Dhabi, UAE	449 (3.7)	⊛

Mathematics Achievement Distribution



⊙ Country average significantly higher than the centerpoint of the TIMSS 8th grade scale

⊛ Country average significantly lower than the centerpoint of the TIMSS 8th grade scale



SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

The top five performing countries in Mathematics were the East Asian countries of Korea, Singapore, Chinese Taipei, Hong Kong SAR and Japan, in that order. In Science, the top performing countries were Singapore, Chinese Taipei, Korea, Japan and Finland, in that order. There was a substantial range in performance from the top-performing to the lower-performing countries. In Mathematics, fifteen countries had an average achievement above the scale average of 500, while thirty other countries had an average achievement below the scale average of 500. In Science, eighteen countries had an average achievement above the scale average while twenty-seven countries had an average achievement below the scale average of 500. Despite Botswana's participation at a higher grade (higher age), it was ranked third from the bottom in both Mathematics and Science.

Performance of Botswana Students at International Benchmarks

The percentage of Botswana students reaching International Benchmark is shown in Table 3.2. Description of international benchmark is discussed in full in Chapter Two.

Table 3.2: *Percentages of Botswana Students Reaching each International Benchmark*

Benchmark	Percentage of students reaching each benchmark in					
	Mathematics			Science		
	2003	2007	2011	2003	2007	2011
Advanced	0.0	0.0	0.0	0.0	0.0	1.0
High	1.0	1.0	2.0	1.0	2.0	6.0
Intermediate	7.0	7.0	15.0	10.0	11.0	28.0
Low	32.0	32.0	50.0	35.0	35.0	55.0

In 2011, 50% of the students from Botswana failed to reach even the lowest benchmark in mathematics while in science the corresponding percentage was 45. The implication is that our Form Two students cannot handle materials that could be handled with ease by students of a lower grade (lower age) from other countries. When comparing Botswana students reaching each benchmark with the top performing countries, the results are alarming as presented in Table 3.3.

Table 3.3: *Students Reaching International Benchmarks*

Country	Mathematics				Science				Country
	Advanced	High	Intermediate	Low	Advanced	High	Intermediate	Low	
Korea	47	77	93	99	40	69	87	96	Singapore
Singapore	48	78	92	99	24	60	85	96	Chinese Taipei
Chinese Taipei	49	73	88	96	20	57	86	97	Korea
Hong Kong	34	71	89	97	18	57	86	97	Japan
Japan	27	61	87	91	13	53	88	99	Finland
Botswana	0	2	15	50	1	6	26	55	Botswana

The percentage of Botswana students reaching the Low benchmark in Mathematics is almost the same as those reaching the Advanced benchmark for the top three performing countries of Korea, Singapore and Chinese Taipei. For science on the other hand, the percentage of Botswana students reaching the Low benchmark is almost the same as for those reaching the High benchmark for the top five performing countries.

Students' Performance in Mathematics and Science by Content Domains

There were four content domains in both Mathematics and science. In the Mathematics content domains, students performed best in Algebra (406.81) and the least performance in Geometry (380.68). On the other hand, the performance in the Science content domains was best in Physics (417.03) with the least performance in Earth Science (384.39). The results are shown in Table 3.4.

Table 3.4: *Performance in Mathematics and Science Content Domains*

n	%	Mathematics			Science		
		Content domain	Mean (SE)	SD	Content domain	Mean (SE)	SD
5,400	100	Algebra	406.81 (3.21)	70.92	Biology	401.04 (3.90)	114.47
5,400	100	Data and Chance	390.67 (3.20)	85.48	Chemistry	402.95 (3.61)	107.93
5,400	100	Geometry	380.68 (2.98)	86.27	Earth Science	384.39 (4.25)	107.57
5,400	100	Number	392.07 (3.27)	89.71	Physics	417.03 (3.57)	104.31

The mean mark for Algebra had the smallest standard deviation suggesting that the marks were clustered around the mean than in any other content domain, while in science, it was the same for Physics.

Performance by cognitive domains

Test items were set according to the cognitive domains of Knowing, Applying, and Reasoning. Figure 3.1 shows how students performed in each cognitive domain.

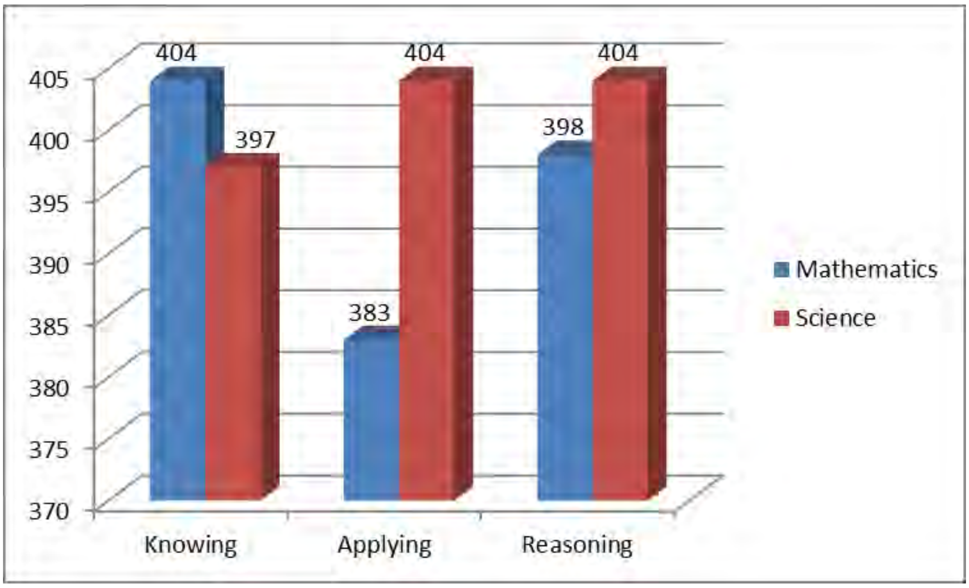


Figure1: *Students' performance by cognitive domains*

In mathematics, students performed best in Knowing, while in science they performed worst in Knowing. It is surprising that students would know high order items than low order items which the form the basis of understanding abstract reasoning.

Summary

Botswana students performed below per. They scored 397 in Mathematics and 404 in Science. Despite Botswana's participation at a higher grade (higher age), it was ranked third from the bottom in both Mathematics and Science. Compared to other participating countries, Botswana fared poorly, coming third from the bottom in both subjects. The percentage of Botswana students reaching the lowest International Benchmark is 50% in mathematics while in science it was 55%. Thus our Form Two students could not handle materials that were handled with ease by students of a lower grade (lower age) from other countries. Students performed best in Algebra and the lowest performance was in Geometry. On the other hand, the performance in the Science content domains was best in Physics with the least performance in Earth Science.

Recommendations

There is need to overhaul the education system so that our students learning can be at par with the international standard.

Teachers need to be resourced better on subject content and instructional methodologies so that they impart knowledge to the students which can enable them to compete with the rest of the world

Mathematics syllabus should emphasise high order skills objective so that students are bale to apply what they learn to real life situations.

CHAPTER FOUR

STUDENTS BACKGROUND VARIABLES AND PERFORMANCE

Analysis was conducted according to students background variables to determine which ones were associated with performance most. Such background variables were such as: sex, number of books, home possessions, home support, and bullying at school.

Performance in Mathematics and Science by Sex

Table 4.1 and Figure 4.1 show the proportion of students by sex and their performance in Mathematics and Science. Girls were slightly more (51.46%) than boys (48.54%). The results indicated that girls performed better than boys in Mathematics and Science, although the means were not statistically significantly different from each other.

Table 4.1: *Performance in Mathematics and Science by Sex*

Sex	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
Girls	2,772	51.46	403.34 (2.86)	75.43	1,2: 13.71	409.64 (4.31)	99.94	1,2: 10.70
Boys	2,628	48.54	389.63 (3.04)	79.33		398.94 (3.65)	107.26	

**Statistically significant at 5% level*

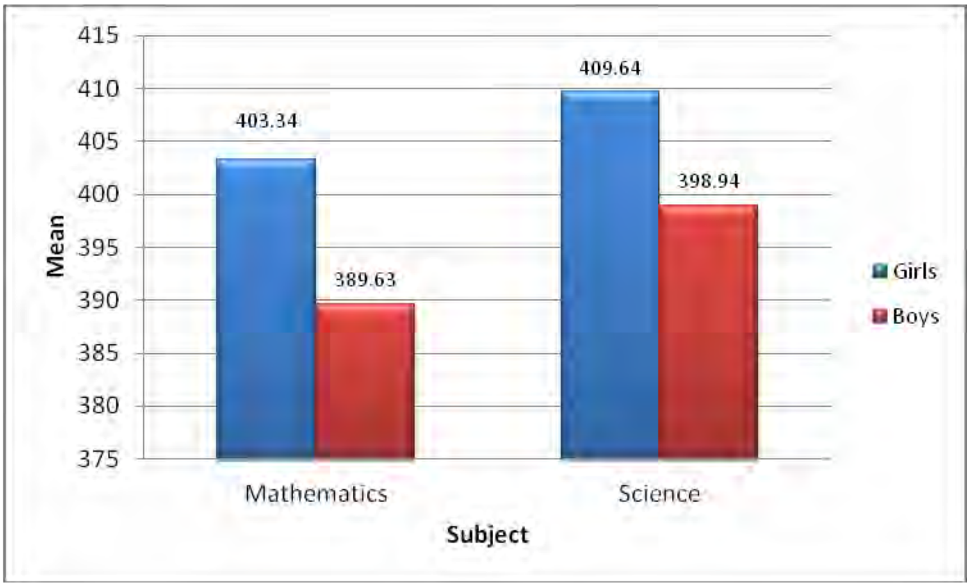


Figure 4.1: Performance in Mathematics and Science by Sex

Performance by Content Domains by Sex

Table 4.2 shows performance of students in Mathematics and Science content domains by sex. The results indicate that girls performed better than boys in almost all the domains in the two subjects. In Mathematics, both boys and girls performed best in Algebra with mean of 398.61 and 414.54 respectively.

Table 4.2: *Performance in Mathematics and Science Content Dimensions by Sex*

Sex	n	%	Mathematics				Science			
			Content Domain	Mean (SE)	SD	Diff	Content Domain	Mean (SE)	SD	Diff
Girls	2,772	51.46	Algebra	414.54 (3.74)	68.48	1,2: 3.21*	Biology	408.79 (4.60)	110.67	1,2: 2.44*
Boys	2,628	48.54		398.61 (3.26)	72.51			392.83 (4.65)	117.79	
Girls	2,772	51.46	Data and Chance	397.89 (4.33)	83.93	1,2: 2.79*	Chemistry	413.15 (3.76)	103.60	1,2: 3.64*
Boys	2,628	48.54		383.02 (3.12)	86.40			392.14 (4.38)	111.31	
Girls	2,772	51.46	Number	400.40 (4.04)	88.10	1,2: 3.28*	Earth Science	387.96 (4.52)	104.54	1,2:1.10
Boys	2,628	48.54		383.23 (3.34)	90.54			380.60 (4.94)	110.55	
Girls	2,772	51.46	Geometry	380.91 (4.74)	83.93	1,2:.07	Physics	415.93 (3.78)	100.23	1,2:-.37
Boys	2,628	48.54		380.45 (3.91)	88.62			418.20 (4.20)	108.46	

**Statistically significant at 5% level*

The difference between these means is statistically significant at 5% level. The best performance for both boys and girls in Science was in Physics by 418.20 and 415.93 respectively. This is the only domain that boys outperformed girls, even though the difference between the two means was statistically non-significant. Irrespective of sex, students perform lowest in Geometry for Mathematics and Earth Science for Science.

Performance in Mathematics and Science Cognitive Domains by Sex

Table 4.3 and Figure 4.2 show the results of the performance by students by the cognitive domains by sex. In mathematics cognitive domains, the best performance is in *Knowing* for both boys and girls, and the difference between the means is statistically significant at 5% level. In Science, girls performed best in *Reasoning* with a mean of 410.65, while the boys' best performance with a mean of 401.15 was in *Applying*.

Table 4.3: *Performance in Mathematics and Science by Cognitive Domains by Sex*

Domain	Sex	n	%	Mathematics			Science		
				Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
Knowing	Girls	2,772	51.46	412.18 (2.81)	76.90	1,2: 17.07	405.84 (4.18)	120.55	1,2: 17.53
	Boys	2,628	48.54	395.11 (3.09)	79.71		388.31(4.26)	129.18	
Applying	Girls	2,772	51.46	387.22 (2.92)	80.44	1,2: 8.22	406.22 (3.60)	98.72	1,2: 5.07
	Boys	2,628	48.54	379.00 (3.65)	83.74		401.15 (3.86)	107.36	
Reasoning	Girls	2,772	51.46	401.80 (2.64)	78.06	1,2: 8.69	410.65 (4.06)	97.78	1,2: 13.56
	Boys	2,628	48.54	393.11 (2.85)	82.48		397.09 (4.41)	104.53	

**Statistically significant at 5% level*

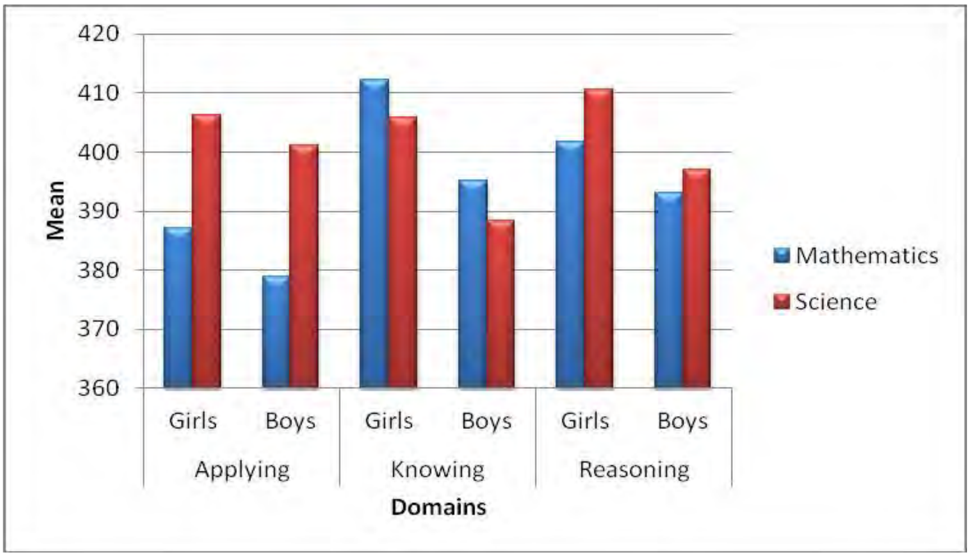


Figure 4.2: Performance in Mathematics and Science by Cognitive Domains by Sex

Students' Performance by Number of books

The relationship between Mathematics and Science achievements and the number of books is somewhat positive. A higher number of books is associated with higher performance. The results, shown in Table 4.4 indicate that this is only valid to some extent. The performance increases from students who come from homes with 0-10 books to those coming from homes with 26-100 books. The mean performance of students coming from homes with more than 100 books is lower than the mean for students who come from homes with 26–100 books. The differences between the two means are statistically significant at 5% level for both Mathematics and Science.

Table 4.1: *Performance in Mathematics and Science by Number of Books At Home*

Number of books	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
0 - 10 books	2,076	38.62	393.97 (2.23)	71.17	1,2:1.74 1,3:-28.69 1,4-2.15 2,3: -30.43 2,4: -3.89 3,4:26.54*	396.34 (3.54)	96.91	1,2: -6.24 1,3: -40.97 1.4: -11.94 2.3: -34.73 2.4: -5.70 3.4: 29.03*
11 - 25 books	2,089	39.08	392.23 (3.10)	75.95		402.58 (4.24)	101.73	
26 - 100 books	742	13.99	422.66 (4.47)	80.63		437.31 (5.67)	103.94	
More than 100 books	442	8.31	396.12 (6.67)	94.78		408.28 (8.96)	101.23	

**Statistically significant at 5% level*

Students Performance by Home possessions

Home possessions are to some extent indicators of the socio-economic status of the parents. Students' families were categorized into three levels; *High*, *Medium*, and *Low*, after grouping together several variables to form an index. The *High* level means that the family has the majority of the home possessions; the *Medium* level means the family has some of the home possessions; and, the *Low* level means that the family has very few of the home possessions. The home possession index was made from the following variables; a *Computer, a Study desk/table for your use, Books of your very own, Own room, Internet connection, Calculator, Dictionary, Running tap-water, Electricity, Television and Radio*. The majority of the students came from families at the *Medium* level, and very few from families at the *Low* level of home possessions. Students who came from families with a *High* level of home possessions performed better than those at the other two categories in both subjects, followed by those at the *Medium* category. The results are shown on Table 4.5.

Table 4.1: *Performance in Mathematics and Science by Home Possessions*

Level of possession	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
High	1,435	26.89	422.30 (3.91)	76.08	1,2: 29.25* 1,3: 51.25* 2,:3: 22.00*	441.10 (4.94)	96.58	1,2: 42.04* 1,3: 73.53* 2,3: 31.49*
Medium	3,122	58.70	393.05 (2.18)	75.53		399.06 (3.19)	102.17	
Low	782	14.41	371.05 (3.87)	73.36		367.57 (5.50)	105.11	

**Statistically significant at 5% level*

Students Performance by Home support

The relationship between frequency of parental support and the students' achievements in the two subjects suggests that students who came from homes where parental support was frequent obtained low mean performance. Students who never or almost never got support from their parents got the highest mean in Mathematics (433.60) and Science (455.29), while those who got support everyday performed lowest with a mean of 396.60 in Mathematics and 404.54 in Science. The results are in Table 4.6.

Table 4.1: *Performance in Mathematics and Science by Home Support*

Frequency	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
Every day or almost every day	1,935	37.30	396.60(2.90)	71.00	1,2: -0.51 1,3: -3.40 1,4:-37.00 2,3:-2.89 2,4:-36.49 3,4:-33.60	404.54(3.37)	94.20	1,2:-1.08 1,3:-0.77 1,4:-50.75 2,3:0.31 2.4:-49.67 3.4:-49.98
Once or twice a day	2,031	39.16	397.11(2.73)	76.68		405.62(3.94)	103.63	
Once or twice a month	899	17.30	400.00(4.55)	86.05		405.31(5.95)	115.19	
Never or almost never	317	6.23	433.60(4.59)	71.30		455.29(6.68)	92.03	

**Statistically significant at 5% level*

Students' Performance by Bullying at School

Several statements that imply bullying that students could be subjected to by other students at school were put together to form an index *Bullying at School*. The statements are: *I was made fun of or called names; I was left out of games or activities; Someone spread lies about me; Something was stolen from me; I was hit or hurt by other students;* and, *I was made to do things I didn't want to do.*

The result indicates that most of the students (57.96%) were subjected to some form of bullying *a few times a year*, followed by those who have *never* experienced bullying (23.54%). Students who were *never* bullied performed better than the rest in both Mathematics and Science. Students who were subjected to bullying *at least once a month* performed the least in Mathematics and Science with a mean of 360.17 and 349.38 respectively. The results are in Table 4.7.

Table 4.1: *Performance in Mathematics and Science by Bullying at School*

Frequency	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
At least once a month	832	18.50	378.95 (3.43)	76.95	1,2:-16.91	376.44 (5.01)	108.24	1,2:-28.14
A few times a year	2,589	57.96	395.86 (2.92)	76.63	1,3: -44.85	404.58 (4.32)	102.50	1,3:-64.23
Never	1,035	23.54	423.80 (3.60)	69.64	2,3: -27.94	440.67 (3.99)	97.46	2,3:-36.09

**Statistically significant at 5% level*

Correlation of Mathematics and Science with Background Variables

Table 4.8 shows the correlation between the students' achievements in Mathematics and Science and some background variables. The correlation between Mathematics achievement and the frequency of parents' support is 0.08, and it is significantly positive. In Science, the correlation is 0.08 as well, which is also significantly positive. The variable frequency of parents' support is an index made up of the following statements: *My parents ask me what I am learning in school*; *I talk about my schoolwork with my parents*; *My parents make sure that I set aside time for my homework*; and, *My parents check if I do my homework*. Students had to indicate the frequency at which these statements apply to them.

The ages of the students had a negative correlation with both Mathematics and Science achievement. The correlation is, however, significant. The negative sign indicates that younger students performed better than older students in both Mathematics and Science.
The other variable, home possession is positively related to Mathematics and Science achievements. This variable is an index representing the following items: *Computer*, *Study desk/table, Books of their own, Own room, Internet connection*, *Calculator, Dictionary, Running tap water, Electricity, Television* and *Radio*. The number of books at home variable also correlated positively with Mathematics and Science achievements. The correlation was significant.

Table 4.2: *Correlation of Indices with Mathematics and Science Achievement*

Variable	Mathematics		Science	
	Correlation	SE	Correlation	SE
Age of the Student	-0.43	0.02	-0.44	0.01
Number of books at home	0.07	0.02	0.10	0.02
Level of home possessions	0.20	0.02	0.22	0.02
Support by parents at home	0.08	0.02	0.08	0.02
Frequency of bad treatment at school	0.18	0.02	0.20	0.02

Regression of Mathematics and Science with Background Variables

The results for the regression analysis of Mathematics and Science achievements on the background variables are shown in Table 4.9. Most background variables are categorical; therefore, they are included in the model as dummy variables. The coefficients obtained will therefore represent the difference between the focal category and the reference category of the variable. For example, the variable 'Home Support' has four categories; *everyday, once or twice a week, once or twice a month* and *never or almost never*. We have kept the category *Every day* as a reference so that all the categories for this variable can be compared to it. The coefficient of 9.32 and 9.74 for *Once or twice a month* category under Mathematics and Science achievement respectively, means that a student who gets support from parents once or twice a month will get a mean achievement of 9.32 and 9.34 points higher than a student who gets support daily, after controlling for other students' background variables. The category *Once or twice a week* under Mathematics achievement is 7.36 points higher.

The term *Constant* in the model represents the mean performance of students who have characteristics that are similar to the reference category in each variable. For example, 420.16 under Science achievement means that a female whose age is around the mean age of the students, coming from a household with home possessions regarded as *High*, have more than 100 books at home, her parents support her daily, and she is never bullied at school by other students, will get a mean performance of 420.16 points.

This is an ideal situation that every female student is aspiring for. But, still under this 'best' set-up, Botswana students fail to score the minimum 500 points required by international standards. However, the means are much better than those of students who do not have the characteristics specified by the reference categories. In the model, all contrasts that are negative implying that a student who possesses characteristics different from those specified by the reference category, will have a mean lower than 438.56 and 420.16 in Mathematics and Science respectively. This analysis then suggests that when more factors are controlled for in the model, better estimates for the mean achievements can be obtained and proper classification of students can be achieved.

Table 4.3: *Regression of Variables with Mathematics and Science Achievement*

Variables	**Mathematics**			**Science**		
	Coefficients	SE	t-Value	Coefficients	SE	t-Value
Constant	438.56	7.45	58.89*	420.16	5.90	71.26*
Boys	8.77	3.35	2.61*	0.85	2.86	0.30
Age of students	-45.28	2.06	-21.95*	-33.76	1.71	-19.79*
Number of books at home						
0 – 10 books	0.58	6.87	0.08	7.55	4.88	1.55
11 – 25 books	-0.91	6.40	-0.14	0.21	4.61	0.05
26 – 100 books	23.03	7.30	3.15	22.96	5.52	4.16
Level of home possessions						
Low	-48.28	6.47	-7.47*	-34.11	4.82	-7.07*
Medium	-24.19	4.00	-6.05*	-17.89	3.22	-5.56*
Parents support at home						
Never or almost never	51.89	5.90	8.79*	36.69	4.68	7.85*
Once or twice a month	9.32	3.99	2.33*	9.74	4.38	2.23*
Once or twice a week	7.36	3.34	2.21*	5.26	2.78	1.89*
Frequency of bullying at school						
Few times a year	-24.55	3.44	-7.14*	-19.32	2.93	-6.59*
At least once a month	-48.94	5.15	-9.50*	-32.82	4.31	-7.61*

**Statistically significant at 5% level*

Summary

The study showed that girls were slightly more (51.46%) than boys (48.54%), and girls performed better than boys in both Mathematics and Science content domains, although the means were not statistically significantly different from each other; they also performed better in almost all the domains in the two subjects. Irrespective of sex, students perform lowest in Geometry for Mathematics and Earth Science for Science. In mathematics cognitive domains, the best performance was in *Knowing* for both boys and girls, while in science, girls performed best in *Reasoning* with a mean of 410.65, while the boys performed best with a mean of 401.15 in *Applying*.

Some background variables that affected students' achievement were age, home possession, home support, bullying, and student's attitudes. Positive home background variables affected students positively while negative home background factors affected students negatively.

Recommendations

Schools should be well equipped with resources both human and physical resources to facilitate learning. Such resources include but not limited to books in the library, laboratory equipment, agriculture equipment, electronic gadgets at the library such computers, readers, Televisions, video and audio machines, internet and so on.

The introduction of assistant teacher or teacher Aid accompanied by class size reduction should be given high prominence. This would allow remedial teaching within the official lesson time for those lagging behind and also assist the gifted students since students learn at different paces.

Bullying should be tackled head-on, as an emerging social problem in schools, by all stakeholders in education. The ministry should consider introducing psychologists and Counsellors in schools who will be able to identify and counsel students who are being bullied and those bullying other and attend to them as soon as possible. Since lack of engagement is one of the factors contributing to bullying, schools should introduce a number of sporting activities which will keep all students engaged in one form or the other, thereby denying them the chance to engage in this anti-social activity.

CHAPTER FIVE

TEACHERS' BACKGROUND VARIABLES AND STUDENTS' PERFORMANCE

The importance of the teacher in the learning of the students cannot be overemphasised. The role of teachers is to facilitate learning, which involves equipping students with knowledge and skills relevant at each level. It is therefore imperative that the teachers themselves possess the necessary knowledge and skills to effectively perform the duties expected of them. Moreover, the environment within which they function, as well as the associated resources, should necessitate that such duties be performed efficiently and effectively.

In this chapter, an attempt is made to evaluate teacher characteristics/variables and relate such variables to students' performance. The characteristics of interest include; sex of the teacher, age, years of experience in teaching, as well as the environment or the resources availed to the teachers.

Demographic Variables

Part of this study deals with demographic variables such as sex, age, educational attainment, as well as the experience of teachers as they relate to students' performance in Mathematics and Science.

Teachers' Gender

In this study, the effect of the gender of the teacher, that is, male or female, and student performance has been investigated. The results are captured in Table 5.1.

Table 5.1: *Teacher Gender and Students' Performance*

Subject	Gender	n	%	Mean(SE)	SD	Diff
Mathematics	Female	2224	43.52	396.07(4.17)	77.92	1,2: -1.20
	Male	2933	56.48	397.27(3.41)	77.63	
Science	Female	2134	40.16	411.04(6.06)	102.26	1,2: -11.99
	Male	3111	59.84	399.05(4.60)	104.63	

**Statistically significant at 5% level*

In Mathematics, most of the teachers (56.48%) are males while female teachers constituted 43.52%. The results showed that the difference in performance between students taught by male teachers and those who were taught by female teachers is not significant. In Science, most of the teachers (59.84%) are males while females constituted 40.16% of the Science teachers. The results showed statistically non-significant differences in performance between students who were taught by male teachers compared to those who were taught by female teachers.

Age of the Teacher

The age of a teacher is also a factor of interest in this study. The age of a teacher was grouped into three categories; *under 29, 30-49 and above 50*. The results are presented in Table 5.2.

Table 5.2: *Teachers' Age and Students' Performance*

Subject	Age	n	%	Mean(SE)	SD	Diff
Mathematics	Under 30 years	1516	28.33	393.24(4.43)	77.57	1,2: -5.22
	Between 30 and 49 years	3599	70.97	398.46(3.54)	77.79	1,3: 28.85*
	50 and above years	42	0.69	364.39(5.75)	69.37	2,3: 34.07*
Science	Under 30 years	714	18.64	353.81 (14.08)	130.04	1,2: -10.46
	Between 30 and 49 years	214	4.78	390.79 (40.78)	133.39	1,3: -19.01*
	50 and above years	3 062	76.59	372.91 (7.28)	129.09	2,3: 17.88*

**Statistically significant at 5% level*

In Mathematics, the significance difference in performance between students who were taught by teachers of different age groups was recorded twice. The first significant difference was recorded between students who were taught by teachers of *under 29* years of age and those who were taught by teachers above 50 years of age. The mean performance of those who were taught by teachers under 29 was 393.24 and those taught by teachers above 50 was 364.39.

Teachers' Level of Education

Mathematics and Science teachers were requested to indicate their levels of qualification. These were categorised as follows: *At most Senior Secondary*; *At most Diploma*, and *At least first degree*. The teachers' qualifications were then linked to the performance of the students. Their responses are as recorded in Table 5.3.

Table 5.3: *Teachers' Level of Education and Students' Performance*

Subject	Level of Education	n	%	Mean(SE)	SD	Diff
Mathematics	At most diploma	4394	87.59	397.98(2.55)	76.07	1,2: 8.36
	At least first degree	612	12.41	389.62(12.55)	88.92	
Science	At most senior secondary	71	1.37	411.79(30.22)	99.56	1,2: 7.40
	At most diploma	3485	68.80	404.39(3.89)	101.92	1,3: 10.27
	At least first degree	1614	29.83	401.52(7.71)	108.27	2,3: 2.87

**Statistically significant at 5% level*

Most of the students were taught mathematics by teachers who had *At most Diploma* (87.59%), and the rest of the students were taught by teachers with *At least first degree* (12.41%). Statistically, there was no significant difference in the performance of the students who were taught by Mathematics teachers with the diplomas and those taught by Mathematics teachers with degrees.

About 68.80% of the students were taught science by teachers who had *At most Diploma*; while about 29.83% of the students were taught by teachers who indicated that they had *At least first degree*. As in Mathematics, the level of qualification did not show any massive departure in the performance of the students. Surprisingly, in science a few teachers reported that they have *At most Secondary* qualifications while in mathematics, there was none.

Mathematics Teachers' Major Area of Study and Students' Performance in Mathematics

Teachers were requested to indicate their area of specialisation during their post-secondary education. The areas were listed as Mathematics, Biology, Physics, Chemistry, General Science, Education – Mathematics, Education – Science, Education – General and Other. The results are shown in Tables 5.4 and 5.5.

Table 5.4: *Mathematics Teachers' Major Area of Study and Students' Performance*

Major area of study		n	%	Mean (SE)	SD	Diff
Mathematics	Yes	4333	86.05	397.72(2.91)	78.02	1,2: 4.93
	No	751	13.95	392.79(3.90)	76.09	
Biology	Yes	503	10.38	393(10.79)	80.52	1,2: -4.27
	No	4577	89.62	397.27(2.55)	77.39	
Physics	Yes	617	12.36	413.35(11.72)	80.62	1,2: 19.74
	No	4443	87.64	393.61(2.38)	76.25	
Chemistry	Yes	500	9.64	400.82(8.88)	75.55	1,2: 4.68
	No	4542	90.36	396.14(2.61)	77.92	
General science	Yes	380	8.01	410.96(16.74)	83.78	1,2: 15.03
	No	4587	91.99	395.93(2.39)	77.02	
Education – Mathematics	Yes	1941	37.89	394.79(4.53)	81.18	1,2: -3.86
	No	3002	62.11	398.65(3.05)	75.62	
Education – Science	Yes	590	12.14	407.87(10.25)	88.08	1,2: 12.09
	No	4391	87.86	395.78(2.52)	75.98	
Education – General	Yes	542	11.49	398.87(11.09)	84.70	1,2: 1.89
	No	4401	88.51	396.98(2.77)	76.78	
Other	Yes	391	7.65	390.28(8.31)	76.84	1,2: -8.40
	No	4176	92.35	398.68(2.89)	78.07	

**Statistically significant at 5% level*

In Mathematics, most of the students (86.05) were taught by teachers who specialised in Mathematics followed by those students who were taught by teachers who specialised in Mathematics Education. The performance in Mathematics for both groups of students was statistically non-significant.

Table 5.5: *Science Teachers' Major Area of Study and Students' Performance*

Major area of study		n	%	Mean (SE)	SD	Diff
Mathematics	Yes	1328	27.46	418.54(7.53)	102.09	1,2: 20.69
	No	35.91	72.54	397.85(4.53)	104.39	
Biology	Yes	2731	55.68	403.20(5.58)	104.68	1,2: -1.62
	No	2188	44.32	404.82(5.80)	103.27	
Physics	Yes	1599	34.80	413.74(6.85)	102.45	1,2: 15.82
	No	3253	65.20	397.92(4.89)	104.50	
Chemistry	Yes	1936	40.82	409.91(6.79)	105.36	1,2: 10.76
	No	2947	59.18	399.15(4.820	102.89	
General science	Yes	1198	24.31	397.90(6.86)	101.16	1,2: -8.08
	No	3655	75.69	405.98(4.69)	104.92	
Education – Mathematics	Yes	659	14.44	411.89(9.53)	100.46	1,2:9.89
	No	4193	85.56	402.00(4.46)	104.59	
Education – Science	Yes	2511	52.32	401.06(5.63)	105.34	1,2: -5.53
	No	2335	47.68	406.59(5.74)	102.63	
Education – General	Yes	768	16.30	401.68(8.28)	99.57	1,2: -2.13
	No	4005	83.70	403.81(4.63)	104.97	
Other	Yes	799	17	407.54(8.50)	99.89	1,2: 20.69
	No	3878	83	402.21(4.73)	104.64	

**Statistically significant at 5% level*

For Science, most of the students (at least 50%) were taught by teachers who had majored in Biology and Science Education, while about 40.82% of the students were taught Science by teachers who had specialised in Chemistry. Students' performance was statistically non-significant regardless of the discipline the teachers had majored on.

Characterisation of Teachers' Professional Attitudes, Behaviours, Expectations and Practices and Students' Performance

In this case, teachers were asked to express their views on the extent of their job satisfaction, understanding of the school's curricular goals, degree of success in implementing the curriculum, expectations on students' achievement, parental support for students' achievement, parental involvement in school activities, students' regard for school property and students' desire to do well in school. These were then related to students' performance to determine whether there is any effect on the students' performance. The results are summarized in the Table 5.6.

Table 5.6: *Teacher Characterisation and Students' Performance in Mathematics and Science*

		n	%	Mean (SE)	SD	Diff
Mathematics						
Job satisfaction	High	1854	36.01	394.43(4.88)	78.66	1,2: -1.81
	Medium	1766	36.77	396.24(5.02)	77.70	1,3: -6.74
	Low	1394	27.22	401.17(77.11)	77.11	2,3: -4.93
Understanding of curricular goals	High	4237	81.69	397.09(2.97)	78.62	1,2: 3.32
	Medium	738	15.42	393.77(4.32)	75.00	1,3: -6.09
	Low	146	2.89	403.18(13.48)	68.96	2,3: -9.41
Degree of success in implementing the school curriculum	High	3667	71.03	399.59(3.36)	79.95	1,2: 9.99*
	Medium	1202	24.93	389.60(3.16)	72.30	1,3: 8.73
	Low	213	4.04	390.86(7.98)	70.77	2,3: -1.26
Expectation for student achievement	High	3533	68.39	400.99(3.49)	78.81	1,2: 10.99*
	Medium	1436	28.88	390.00(4.27)	73.81	1,3: 39.04
	Low	152	2.73	361.95(23.72)	80.53	2,3: 28.05
Parental support for student achievement	High	353	6.93	454.65(10.45)	70.83	1,2: 34.97*
	Medium	918	17.74	419.68(7.26)	79.21	1,3: 68.17*
	Low	3813	75.33	386.48(2.32)	74.42	2,3: 33.20*
Parental involvement in school activities	High	181	3.07	456.43(8.17)	66.16	1,2: 39.79*
	Medium	1150	23.10	416.64(5.93)	78.35	1,3: 68.38*
	Low	3790	73.83	388.05(2.79)	75.85	2,3: 28.59*
Students' regard for school property	High	392	7.50	413.89(7.30)	74.82	1,2: 9.49
	Medium	2020	40.69	404.40(4.59)	80.07	1,3: 25.81*
	Low	2637	51.81	388.08(3.33)	75.85	2,3: 16.32*
Students' desire to do well in school	High	401	8.02	432.12(13.00)	80.13	1,2: 27.24
	Medium	1892	38.18	404.88(5.04)	78.59	1,3: 46.47*
	Low	2794	53.80	385.65(2.77)	74.76	2,3: 19.23*
Science						
Job satisfaction	High	1364	26.18	404.21(6.91)	99.82	1,2: 1.33
	Medium	2276	43.98	402.88(6.53)	106.80	1,3: -0.90
	Low	1487	29.84	405.11(6.39)	102.80	2,3: -2.23
Understanding of curricular goals	High	3895	76.01	406.16(4.79)	104.83	1,2: 9.21
	Medium	1098	21.30	396.95(6.38)	100.96	1,3: 11.33
	Low	134	2.68	394.83(12.86)	94.17	2,3: 2.12
Degree of success in implementing the school curriculum	High	2871	55.40	408.67(5.69)	105.59	1,2: 11.38
	Medium	1955	39.52	397.29(5.22)	102.27	1,3: 11.31
	Low	232	5.08	397.36(10.48)	96.62	2,3: -0.07
Expectation for student achievement	High	3581	70.49	410.33(4.46)	102.48	1,2: 17.95*
	Medium	1237	23.83	392.38(7.14)	104.82	1,3:38.07*
	Low	309	5.68	372.26(11.06)	106.26	2,3: 20.12
Parental support for student achievement	High	333	6.06	483.81(13.01)	91.87	1,2: 67.68*
	Medium	777	15.95	416.13(8.39)	99.67	1,3: 88.76*
	Low	3950	77.99	395.05(3.95)	102.46	2,3: 21.08*
Parental involvement in school activities	High	287	5.69	443.50(19.24)	106.14	1,2: 19.47
	Medium	911	16.61	424.03(7.62)	101.40	1,3: 46.82*
	Low	3929	77.70	396.68(3.98)	102.94	2,3:27.35*
Students' regard for school property	High	193	3.72	446.21(18.22)	96.26	1,2: 26.80

	Medium	1434	28.71	419.41(8.10)	104.80	1,3: 50.84*
	Low	3395	67.57	395.37(4.41)	102.50	2,3: 24.04*
Students' desire to do well in school	High	438	8.66	460.54(14.97)	98.55	1,2: 44.48*
	Medium	1968	416.06	416.06(5.96)	100.65	1,3: 74.99*
	Low	2721	52.21	385.55(4.26)	102.28	2,3: 30.51*

**Statistically significant at 5% level*

Job Satisfaction

For Mathematics, about 36.01% of the students were taught by teachers who indicated that the teachers' job satisfaction in their schools was high. At least 36.77% of the students were taught by teachers who said job satisfaction was medium in their schools, while 27.22% of the students were taught by teachers who said that job satisfaction in their school was low. The expectation is that, high job satisfaction in an organisation goes hand in hand with higher performance but in this entire instance, there was no significant difference in the performance of the students who were taught by teachers who indicated different levels of job satisfaction.

For Science, most of the students (43.98%) were taught by teachers who were moderately satisfied with their working places followed by the cohort taught by teachers with low and then the high levels of job satisfaction. Just like in Mathematics, the degree or level of job satisfaction of the teachers in schools did not affect the performance of the students.

Understanding of the Curricular Goals

In Mathematics, almost all of the students (81.69%) were taught by teachers who indicated that they have a high understanding of the curricular goals, followed by about 15.42% students who were taught by teachers who indicated that they have a moderate understanding of the curricular goals. Just like with Job satisfaction, the expectations in the performance of the students were shattered as there was no significance difference in students' performance from the two groups of students.

In Science, about 76.01% and 21.30% were taught by teachers who reported that they have a high and medium understanding of curricular goals respectively. Likewise, there was no significant difference in performance from the two cohorts.

Degree of Success in Implementing the School Curriculum by Teachers and Students' Performance

In Mathematics, most of the students (71.03%) who took part in this study were taught by the teachers who indicated that they had a high degree of success in implementing the school curriculum followed by the students (24.93%) whose teachers indicated they have a moderate or medium degree of success in implementing the school curriculum. As expected naturally, the cohort which was taught by teachers with a high degree of success in the school curriculum's implementation performed significantly better than the cohort taught by teachers who indicated having a moderate degree of success in implementing the school's curriculum. This implies that the Ministry of Education and Skill Development may have to train teachers on how to implement the school curriculum.

In Science, 55.40% of the students were taught by teachers who reported that they have a high degree of success in implementing the curriculum, while 39.52% of the students were also taught by teachers who reported that they have medium degree of success in implementing the curriculum. The performance of the two groups of students was more or less the same as there was no statistical difference of the mean scores.

Expectation in Student Achievement by Teachers and Students' Performance

In Mathematics, about 68.39% of the students were taught by teachers with high expectations in performance and achievement of their students. This group of students had performed significantly better than those students (28.88%) who were taught by teachers with medium or moderate expectation of their students' achievement and performance. In Science, 70.49% of the students were taught by teachers who said they had high expectations for their students' achievement while about 23.83% of the students were taught by teachers who reported that they had moderate expectation of their students' achievement. Even though most the students were taught Science by teachers who reported that they had high expectations of their students' achievement, their mean scores was not significantly different from that of students who were taught by teachers with moderate expectations on the performance of their students.

Parental Support for Student Achievement and Students' Performance

Parental support in students' achievement and performance in schools is very important. In Mathematics, about 75.33% of the students were taught by teachers who indicated that parental support for students' achievement and performance was low, followed by those students (17.74%) who were taught by teachers who said parental support for students' achievement was medium or average, while 6.93% of the students were taught by teachers who said parental support for students' achievement was high. The results showed a positive trend of parents supporting their students' learning. This was confirmed by a significantly better performance by the students who were taught by teachers who indicated a high parental support for students' achievement than for those students who were taught by teachers who indicted that parental support was moderate or low.

In Science, as in Mathematics, parental support in students' achievement in schools was not there or it was very minimal. Most of the students (77.70%) were taught Science by the teachers who said there was low parental support for students' achievement, followed by 15.95% of the students who were taught by teachers who reported that there was medium parental support for students' achievement in schools. The results showed that where there was parental support, the students performed better. And, in the case of those students who were taught by teachers who indicated that there was low parental support, performance was significantly lower than that of those whose teachers had said parental support in students' achievement was medium.

Parental Involvement in School Activities and Student Performance

In Mathematics, a small proportion of students (3.07%) were taught by teachers who indicated that there was a high involvement of parents in school activities. Parental involvement in schools leaves a lot to be desired, and just like in parental support in students' achievement, the majority of the students (73.83%) were taught by teachers who reported that parental involvement in school activities was low. These students performed significantly lower than those students (23.10%) who were taught by teachers who had indicated that parental involvement was medium or moderate.

In Science, a high number of the students (77.70%) were taught by teachers who said parental involvement in school activities was low and just like in Mathematics, this cohort performed statistically lower than those students (16.61%) whose teachers reported that parental involvement was medium.

Students' Regard for School Property and Students' Performance

In Mathematics, most of the students (51.81%) were taught by teachers who indicated that their students had low regard for school property followed by those students whose teachers said their students had medium regard for school property. Those students whose teachers had indicated that their students had low regard for school property performed significantly lower than those students taught by teachers who said their students had a medium regard to school for school property. For Science, about 67.57% of the students were taught by teachers who reported that their cohort had low regard for school property and this group performed significantly lower than those students (28.71%) whose teachers indicated that their students had medium regard for school property.

Students' Desire to do Well in School and Students' Performance
In Mathematics, about 53.80% of the students were taught by teachers who had indicated that their students' desire to do well in school was low and this cohort performed significantly lower than those students whose teachers had indicated that their students had a medium (38.18%) or high (8.02%) desire to do well in school. But, there was no statistical difference between the performance of the students taught by teachers who indicated that their students had medium and high desire to do well in school.

As in Mathematics, the Science cohort which was taught by teachers who indicated that their students had low desire to do well in school had performed significantly lower than the cohort whose teachers reported that their students had a medium desire to do well in school.

Security and Safety of the School

Safety and security of the teachers and learners in a school are very important to learning and teaching. The teachers were asked to think about the security and safety of the school at which they teach and to indicate whether or not they *Agree a lot*, *Agree a little*, *Disagree a little*, or *Disagree a lot* with the statements about the location of the school, the school's security policies, and the behaviour of the learners. However, the responses were re-categorized into *Agree* or *Disagree* as shown in Table 5.7.

Table 5.7: *Security and Safety of the School*

Subject	Security feature		n	%	Mean (SE)	SD	Diff
Mathematics	The school is located in a safe neighbourhood	Agree	3519	69.65	401.66(3.23)	79.03	
		Disagree	1566	30.35	387.78(3.21)	73.37	1,2: 13.88*
	I feel safe at school	Agree	3650	71.30	399.44(3.18)	79.04	
		Disagree	1435	28.70	392.49(3.89)	73.74	1,2: 6.95
	School's security policies and practices are sufficient	Agree	2631	52.64	400.26(3.77)	76.91	
		Disagree	2454	47.36	394.32(3.99)	78.28	1,2: 5.94
	Students behave in an orderly manner	Agree	2722	53.37	401.09(3.80)	79.93	
		Disagree	2363	46.63	393.27(3.25)	74.67	1,2: 7.82
	Students are respectful of the teachers	Agree	3233	63.51	398.62(3.47)	77.85	
		Disagree	1823	36.49	394.95(4.34)	77.36	1,2: 2.67
Science	The school is located in a safe neighbourhood	Agree	3433	68.65	407.91(4.92)	104.37	
		Disagree	1498	31.35	394.21(5.88)	101.94	1,2: 13.70
	I feel safe at school	Agree	3678	71.60	410.83(4.63)	102.78	
		Disagree	1413	28.40	385.13(5.96)	104.09	1,2: 25.70*
	School's security policies and practices are sufficient	Agree	2915	56.99	409.78(4.84)	102.48	
		Disagree	2145	43.01	395.86(5.60)	104.79	1,2: 13.92
	Students behave in an orderly manner	Agree	2624	50.91	411.49(4.93)	103.80	
		Disagree	2503	49.09	396.00(5.38)	103.26	1,2: 15.49*
	Students are respectful of the teachers	Agree	3058	58.14	409.94(4.64)	103.85	
		Disagree	2069	41.86	395.48(5.87)	103.21	1,2: 14.46

**Statistically significant at 5% level*

The teachers were asked to think of the location of the school and indicate whether or not the school was located in a safe neighbourhood; they felt safe at school; the school's security policies and practices were sufficient; the students behaved in an orderly manner; and the students were respectful of the teachers. The mean scores of those learners whose teachers said they thought positively about the security and behaviour of the students were higher for both Mathematics and Science. A higher percentage had indicated that they agreed a lot that the security and the safety of the school and the teachers were satisfactory. However, in Mathematics, it is only with the concerns of the location and neighbourhood of the school where mean scores differed significantly. But for Science, there were two areas, namely the safety of the school and the behaviour of the students, where the mean scores showed significant differences. The show of significance should underscore the importance of the physical location of the school and the conduct of the students; which is a behavioural aspect. That the teachers feel safe, is a psychological aspect.

Teachers' Views on the Severity of Problems in School Facilities and Students' Performance in Mathematics and Science

Teachers were requested to show whether there is a problem or not with the various conditions in their schools which could be of consequence to the performance of their teaching duties. An attempt was then made to relate their responses to the performance of students in Mathematics and Science. Such conditions include; *school building needs significant repair*, *classroom overcrowding*, *too many teaching hours*, *adequate workspace for preparation and meetings*, and *adequate instructional materials and supplies*. The results are shown in Table 5.8.

Table 5.8: *Teachers' Views on the Severity of Problems in School Facilities and Students' Performance in Mathematics and Science*

Mathematics						
Problem	Severity	n	%	Mean (SE)	SD	Diff
School building needs significant repair	Not a problem	408	8.86	423.94(13.53)	82.76	1,2: 29.86*
	A problem	4639	91.14	394.08(2.50)	77.12	
Classrooms are overcrowded	Not a problem	515	11.70	408.32(10.30)	79.77	1,2: 13.06
	A problem	4570	88.30	395.26(2.640	77.57	
Teachers have too many teaching hours	Not a problem	999	21.39	389.24(7.37)	80.49	1,2: -8.83
	A problem	4053	78.61	398.07(2.80)	76.84	
No adequate workspace for preparation, collaboration, or meeting with students	Not a problem	309	6.72	420.16(18.37)	86.76	1,2: 25.05
	A problem	4776	93.28	395.11(2.51)	77.00	
Teachers do not have adequate instructional materials and supplies	Not a problem	141	3.42	419.96(33.56)	93.39	1,2: 24.22
	A problem	4912	96.58	395.74(2.50)	77.22	
Science						
School building needs significant repair	Not a problem	201	4.39	458.27(25.56)	100.33	1,2: 56.46*
	A problem	4891	95.61	401.81(3.74)	103.35	
Classrooms are overcrowded	Not a problem	924	18.09	422.87(10.09)	107.05	1,2: 23.17*
	A problem	4203	81.91	399.70(3.73)	102.63	
Teachers have too many teaching hours	Not a problem	1079	21.33	400.40(10.32)	112.27	1,2: -4.02
	A problem	4010	78.67	404.42(4.28)	101.37	
No adequate workspace for preparation, collaboration, or meeting with students	Not a problem	507	10.47	398.62(16.08)	116.16	1,2: -5.89
	A problem	4620	89.53	404.51(3.80)	102.27	
Teachers do not have adequate instructional materials and supplies	Not a problem	422	7.99	431.35(18.00)	113.83	1,2: 29.84
		4705	92.01	401.51(3.73)	102.56	

**Statistically significant at 5% level*

Condition of School Buildings and Students' Performance

The majority of teachers reported a serious problem with the condition of school buildings; whereby over 91% of the Mathematics teachers and over 95% of the Science teachers expressed a problem with the state of the school buildings. The mean score, in Mathematics, of students whose teachers have a problem with school buildings is 394.08 compared to 423.94 of students whose teachers do not have any problem with school buildings. A similar pattern is observed in Science whereby the achievement is 401.81 against 458.27. The difference in the mean scores of the students is significant at 5% level in both Mathematics and Science. This implies that more students could be at risk of underperforming due to dilapidated school buildings.

Classroom Overcrowding and Students' Performance
Classroom overcrowding also appears to be a common problem for teachers as reported by over 80% across Mathematics and Science teachers. Although achievement seems to be better among teachers who view overcrowding as a non-problem (mean score where overcrowding was a problem is 395.26 and where it was not is 408.32), in Mathematics, the difference in the achievements of students was not statistically significant at 5% level. On the other hand, Science achievement showed a different picture, whereby the difference in achievements of students was statistically significant with a mean score of 399.70 where there was a problem and 422.87 where there was no problem.

Amount of Teaching Hours and Students' Performance
Surprisingly, the achievements of students in Mathematics seemed better where teachers have a problem with too many teaching hours than when they do not (mean score of 398.07 against 389.24). In relation to Science, the same pattern was observed (404.42 compared to 400.40). However, the tests of significance reveal that there was no difference in the performance of the students in relation to teachers' views on the amount of teaching hours. Generally, the majority of teachers had a problem with too many teaching hours, which is at least 78% of teachers.

Adequate Workspace for Teachers and Students' Performance
In Mathematics, students whose teachers have a problem with adequate workspace for preparation or meetings achieve worse (395.11) than those whose teachers do not have a problem with it (420.16). However, the difference in performance is not statistically significant. In Science, there is a different picture compared to the one observed in Mathematics whereby students whose teachers do not have any problem with adequate workspace for preparation and meetings achieve slightly less than their counterparts, with mean scores of 398.62 and 404.51, for no problem and a problem, respectively, although not statistically significant. It appears there is a serious problem of adequate workspace for preparation as reported by the majority of the teachers, and it negatively affects students' performance in Mathematics and Science.

Adequate Instructional Materials and Supplies, and Students' Performance
Moreover, concerning inadequate instructional materials and supplies, students whose teachers view this not being a problem have higher mean scores in Mathematics and Science than those whose teachers have problems of some sort with inadequate instructional materials and supplies, but not statistically significant.

Teachers' Motivation and Students' Performance

The level of motivation can affect how teachers perform their duties. Expectation is that the more teachers are motivated, the more they are likely to carry out their duties efficiently and effectively, which may have a positive effect on the students' performance. Teacher motivation is an index whereby teachers were responding to a set of statements, which include: *I am content with my profession as a teacher*; *I am satisfied with being a teacher at this school*; *I had more enthusiasm when I began teaching than I have now*; *I do important work as a teacher*; I *plan to continue for as long as I can*; and *I am frustrated as a teacher*. The results are captured in Table 5.9.

Table 5.9: Teachers' motivation and Students' Performance in Mathematics and Science

Subject	Motivation level	n	%	Mean(SE)	SD	Diff
Mathematics	High	1306	26.81	405.35(5.78)	78.44	1,2: 11.32
	Low	3607	73.19	394.03(3.09)	77.32	
Science	High	1240	25.18	414.23(7.83)	106.12	1,2: 14.3
	Low	3717	74.82	399.89(4.55)	103.08	

**Statistically significant at 5% level*

Teachers' Enthusiasm Towards Teaching

The teachers responded to a question that required that they indicate the things they do in class that demonstrated that they were enthusiastic towards teaching. The questions were related to ways of teaching, interaction with the learners and motivating the learners. These include: *summarise what students should have learned from the lesson*; *relate the lesson to students' daily lives*; *use questioning to elicit reasons and explanations*; *encourage all students to improve their performance*; *praise students for good effort*; and, *bring interesting materials to class*. The teachers needed to indicate the frequency with which they did the things that have been listed above. The comparisons are confined to those who did the things *every or almost every lesson* and those that said *about half the lessons*. The results are shown in Table 5.10.

Table 5.10: *Teachers Enthusiasm towards teaching and Students' Performance in Mathematics and Science*

Subject	Frequency	n	%	Mean(SE)	SD	Diff
Mathematics	Every or almost every lesson	2148	42.79	401.07(4.36)	77.66	1,2: 9.50
	Some lessons	2691	54.41	391.57(3.59)	77.66	1,3: 10.23
	Never	140	2.80	390.84(12.56)	70.72	2,3: 0.73
Science	Every or almost every lesson	3285	63.89	402.15(4.99)	104.80	1,2: -4.59
	Some lessons	1914	36.11	406.74(5.48)	102.23	

**Statistically significant at 5% level*

The ways in which the teachers motivate and interact with their students have an effect in teaching and learning, and likewise, they should have an effect in the performance of the students. In that regard, the teachers' enthusiasm was measured by the number of times the teachers summarised what was learned, related what was learnt to daily lives, elicited reasons and explanations, emphasised improvement of performance, praised good effort, or used interesting materials during teaching. From the results, generally, teachers showed a high level of enthusiasm. However, there seems to be no significant difference in the performance of students according to the teachers' level of enthusiasm to teaching.

It turned out that the students whose teachers did the related tasks *every or almost every lesson* had mean scores higher than those whose teachers did the tasks partly or never did the tasks in their lessons, in both Mathematics and Science. It is worth noting that the Science teachers did not indicate that they did not have any enthusiasm, whereas almost 3% of the teachers of Mathematics did.

When the standard error was computed, it did not show any significant difference in the mean scores for both Mathematics and Science. This means that the effect of having to motivate and get motivated made no difference whether it was done every lesson or in some lessons but not others.

The Extent to which Student Factors Limit Teaching and Students' Performance

Teachers were requested to state the extent to which various factors tend to limit teaching. Such factors included: *Students lacking prerequisite knowledge or skills*; *Students suffering from lack of basic nutrition*; *Students suffering from not enough sleep*; *Students with special needs (e.g., physical disabilities, mental or emotional/psychological impairment)*; *Disruptive students*; and *Uninterested students*. These factors were then related to students' performance. The results are summarised in Table 5.11.

Table 5.11: *The Extent to Which Student Factors Limit Teaching and Students' Performance in Mathematics*

Subject	Extent of lmiting	n	%	Mean (SE)	SD	Diff
Mathematics	Not at all	1272	25.33	403.03(4.19)	78.53	1,2: 9.27
	Somewhat	2794	58.53	393.76(3.25)	76.54	1,3: 12.47
	A lot	794	16.15	390.56(6.89)	78.23	2,3: 3.20
Science	Not at all	1011	19.67	429.19(9.50)	106.89	1,2: 29.82*
	Somewhat	3257	64.38	399.37(4.68)	101.96	1,3: 37.05*
	A lot	834	15.95	392.14(7.89)	103.19	2,3: 7.23

**Statistically significant at 5% level*

The above factors affect teaching and learning hence their presence in any learning situation will have an effect in the performance of the students. In that regards the teachers were required to state whether or not the factors mentioned above, that is: *lack of prerequisite knowledge, lack of basic nutrition, lack of sleep, special needs, disruptive behaviour,* and *lack of interest*, in their view, limited how they teach. The teachers' responses fell into the following categories: *Not at All; Somewhat;* and, *A Lot*.

The mean scores of those students whose teachers indicated that the factors did not limit them at all had the highest mean scores in both Mathematics and Science. The highest mean score for Mathematics was 403.03 and 429.19 for Science. However, for Mathematics the differences in the mean scores were non-significant as reported by significant error. This could imply that, for Mathematics the factors affect the teaching in relatively the same way. For Science the measure of standard error shows that the differences are significant between those who indicated that *Not at All* and those who indicated either *Somewhat* or *A Lot*. No significance is reported between the mean scores of those whose teachers indicated *Somewhat* and *A Lot*.

The differences in the significant errors with regards to Mathematics and Science could be due to the fact that Mathematics is taught differently from Science. Science needs more demonstrations or experiments and probably, there is more concentration needed.

Teachers' Interaction with Students' Parents

The relationship between the teachers and the students is very important in a school setup. It should be promoted by an interaction between the students and their teachers and between the teachers and the parents. Teachers were asked how often they: *meet or talk individually with a student's parents to discuss his/her learning objectives* and *send home a progress report on the student's learning*. Their responses were then related to the students' performance in Mathematics and Science. The results are provided in Table 5.12.

Table 5.12: *Teachers' Interaction with Students' Parents and Students' Performance in Mathematics and Science*

Mathematics						
Type of interaction	Frequency	n	%	Mean (SE)	SD	Diff
Meet or talk individually with the student's parents to discuss his/her learning progress	At least once a week	303	6.35	416.25(13.24)	81.72	1,2: 10.04 1,3: 25.14 1,4: 19.18 1,5: 33.50* 2,3: 15.10 2,4: 9.14 2,5: 23.46 3,4: -5.96 3,5: 8.36 4,5: 14.32*
	Once or twice a month	370	6.53	406.21(14.53)	84.87	
	4-6 times a year	249	5.00	391.11(11.18)	73.06	
	1-3 times a year	3351	66.57	397.07(3.50)	76.99	
	Never	772	15.55	382.75(5.06)	75.61	
Send home a progress report on the student's learning	Once or twice a month	165	2.61	447.93(25.33)	85.30	1,2: 40.95 1,3: 53.69* 1,4: 53.12* 2,3: -0.67 2,4: 12.17 3,4: -0.64
	4-6 times a year	334	5.84	406.98(8.47)	73.87	
	1-3 times a year	3964	79.23	394.24(3.10)	77.41	
	Never	618	12.32	394.91(8.17)	76.59	
Science						
Meet or talk individually with the student's parents to discuss his/her learning progress	At least once a week	159	3.23	399.79(9.78)	93.37	1,2: 8.09 1,3: -36.38* 1,4: -4.70 1,5: 9.43 2,3: -44.47* 2,4: -12.79 2,5: 1.34 3,4: 31.68* 3.5: 45.81* 4,5: 14.13
	Once or twice a month	441	8.32	391.70(16.46)	107.89	
	4-6 times a year	411	8.80	436.17(13.48)	104.16	
	1-3 times a year	3288	62.52	404.49(4.49)	103.28	
	Never	872	17.13	390.36(7.43)	101.20	
Send home a progress report on the student's learning	Once or twice a month	181	3.42	387.00(11.25)	97.54	1,2: -10.28 1,3: 8.88 1,4: -1.40 2,3: -10.99 2,4: 8.88 3,4: 19.87
	4-6 times a year	471	9.11	397.28(11.75)	103.10	
	1-3 times a year	3863	73.55	408.27(4.21)	103.43	
	Never	692	13.92	388.40(10.43)	106.76	

**Statistically significant at 5% level*

The teachers were asked to indicate the number of times they meet or individually talk to the students' parents and/or send students' progress report to the parents. The mean scores of those students whose teachers say they meet or individually talk to the students' parents once or twice a month are higher for Mathematics at 406.21 but, for Science at a mean score of 436.17, it is for those students whose teachers said they meet or individually talk to the students' parents 4-6 times a year. Whilst the mean scores are higher at these points, it is worth noting that this accounts for only 6.35% of the respondents in Mathematics and 8.80% of the respondents in Science. A greater proportion of the respondents throughout fell between *1-3 times a year*. The reason could be that, in Botswana, schools have three terms which explains the 3 reporting times.

However, significance in standard error between the mean scores in Mathematics is reported between those who indicated *At least once a year* and those who indicated *1-3 times a year*. Also, between those who indicated *never* and those that indicated *1-3 times a year*. For Science, the significant error is reported from the mean scores of the students whose teachers responded *At least once a year* and those whose teachers indicated *4-6 times a year*.

The second question was whether or not the teachers send home a progress report to the parents. The mean scores of those students whose teachers indicated they meet or individually talk to the students' parents once or twice a month are higher for Mathematics at 447.93 but, for Science at a mean score of 436.17, it is for those whose teachers said *1-3 times a year*. Once again, even though the mean scores are higher at this point in Mathematics, it is for only 2.61% of the respondents. On the other hand, it represents 73.55% of the respondents in Science.

In Mathematics, the significant error is reported between the mean scores of those students whose teachers indicated that they report progress *At least once a week* and those whose teachers said they report progress *4-6 times a year*. There is no significant error reported in Science. There is no significant difference between reporting once a week and reporting once or twice a month as indicated by the measure of significant error. The same goes for meeting or discussing individually with the students' parents.

Confidence in Performing Certain Professional Duties

This is an index whereby teachers were asked a set of questions on their confidence to perform certain tasks with students such as: answering questions; showing students a variety of problem solving strategies or explaining science concepts or principles by doing experiments; providing challenging tasks to capable students; adapting teaching to engage students' interest; and, helping students appreciate the value of learning the subject in question.

The confidence of the teachers as shown by how they interact with their students or how they handle content matter is very important in teaching and in the way the students perform. In that regard, the teachers' confidence was measured by the way they answered questions from students or kept the students interested, how they applied problem solving techniques or their understanding of scientific principles and concepts and likewise, how they motivated students to appreciate learning Mathematics or Science. The mean scores of those students whose teachers indicated that they were very confident had the highest mean scores in both Mathematics and Science as shown in Table 5.13.

Table 5.13: *Teachers' Confidence in Performing Certain Professional Duties and Students' Performance in Mathematics and Science*

Subject	Confidence level	n	%	Mean (SE)	SD	Diff
Mathematics	Very confident	4436	88.10	398.85(2.84)	77.75	1,2: 20.86*
	Somewhat confident	502	10.54	377.99(7.86)	77.98	1,3: 10.90*
	Not confident	71	1.36	387.95(4.52)	71.89	2,3: -9.96
Science	Very confident	4358	84.43	405.62(4.08)	104.54	
	Somewhat confident	818	15.57	393.87(8.66)	100.00	1,2: 11.75

**Statistically significant at 5% level*

Apparently over 80% of the teachers of Mathematics and Science indicated that they were very confident and this translated to the highest mean scores of 398.85 in Mathematics and 405.62 in Science. The lows as indicated by *Somewhat confident* were 377.99 for Mathematics and 393.87 for Science. For Mathematics, the two mean scores as measured by the standard error reported significant difference which means that there is a difference between those students whose teachers indicted that they are very confident as opposed to those whose teachers indicated *Somewhat confident*. However the standard error has not indicated any significance for the Science mean scores.

The Extent to which Teachers Ask their Students to Employ Various Learning Strategies

The teachers were asked to provide information on how often they asked students to employ various strategies that could enhance their learning. Such strategies include: listening when a teacher explains how to solve problem; memorizing rules, procedures and facts; working problems with teacher's guidance; etc. The results are summarized in Table 5.14.

Table 5.14: *The Extent to which Mathematics Teachers ask their Students to Employ Various Learning Strategies and Students' Performance in Mathematics and Science*

Subject	Frequency of employing learning strategy	n	%	Mean (SE)	SD	Diff
Mathematics	Every lesson or almost every lesson	332	6.67	385.87(4.53)	71.34	1,2: -11.40*
	Some lessons	4677	93.33	397.27(2.73)	78.37	
Science	Every lesson or almost every lesson	327	6.19	413.89(10.96)	94.21	1,2: 10.69
	Some lessons	4918	93.81	403.20(3.81)	104.42	

**Statistically significant at 5% level*

In Mathematics, learning strategies included; listening to the teacher when explaining how to solve problem; memorizing rules, procedures and facts; working problems (individually or with peers) while the teacher is occupied with other tasks; working problems together in the whole class with guidance from the teacher; applying facts, concepts and procedures to solve routine problems; explaining their answers; relating what they have learnt in Mathematics to their daily lives; deciding on their own procedures for solving problems; working on problems for which there is no immediately obvious method of solution; and, taking a written quiz. This was made into an index because individually, there seemed to be no significant relation to students' performance. The surprising means of students who employ these strategies in some lessons are significantly higher than of those who employ them in *every or almost every lesson*.

In Science, learning strategies included: observing natural phenomena such as the weather or a plant growing and describing what they see; watching a demonstration of an experiment or investigation, designing or planning experiments or investigations; conducting experiments or investigations; reading their textbook or other resource materials; having students memorise facts and principles; giving an explanation about something they are studying; relating what they are learning in science to their daily lives; doing field work outside the class; and, taking a written quiz. The results show that teachers ask students to employ these strategies *every or almost every lesson* and *in some lessons*. However, there is no significant difference in the performances of students between those asked *every or almost every lesson* and those asked *in some lessons*, as shown in table 5.14 above.

Teachers' Use of Resources

Teachers were asked to respond as to how they use particular resources when they teach Mathematics and Science. For instance, in Science, teachers were asked how they use: textbooks; workbooks or worksheets; science equipment and materials; computer software for science instruction; and, reference materials (e.g. encyclopaedia, dictionary). On the other hand, in Mathematics, teachers were asked how they use: textbooks; workbooks or worksheets; concrete objects or materials that help students understand quantities or procedures; and computer software for Mathematics instruction. Teachers were expected to indicate whether they used these resources for: basic instruction, supplement, or did not use them. The use of these resources was then related to the students' performance, and the results are summarized in Table 5.15.

Table 5.15: *Teachers' Use of Resources and Students Performance in Mathematics and Science*

Subject	Use of resource	n	%	Mean (SE)	SD	Diff
Mathematics	Basic for instruction	182	2.97	405.52(6.13)	71.77	1,2: 8.34 1,3: 21.62* 2,3: 13.28
	Supplement	4432	90.55	397.18(2.88)	78.27	
	Not used	328	6.46	383.90(6.18)	74.65	
Science	Basic for instruction	289	6.07	445.45(13.33)	98.09	1,2: 43.71* 1,3: 64.56* 2,3: 20.85
	Supplement	4799	91.35	401.74(3.68)	103.64	
	Not used	157	2.58	380.89(17.16)	101.35	

**Statistically significant at 5% level*

The results show that, generally, teachers used the resources for supplement (90.55% in Mathematics and 91.35% in Science). In Mathematics, students whose teachers used resources for basic instruction outperformed (mean of 405.52) those whose teachers used resources for supplement and those who did not use at all (with means of 397.18 and 383.90 respectively). However, the difference in use for basic instruction and supplement is not statistically significant at 5% level, but significant for use in basic instruction and none use. On the other hand, in Science, there is a significant difference in the performance of students whose teachers used resources for basic instruction (445.45) compared to those whose teachers used resources for supplement (401.74) and those who did not use (380.89), as shown in Table 5.15 above.

Use of Calculators in Mathematics Lessons

Teachers were asked on the frequencies with which students in their Mathematics lessons used calculators to perform particular activities. The use of calculators was then related to students' performance, and the results are shown in Table 5.16.

Table 5.16: *Use of Calculators in Mathematics Lessons and Students' Performance*

Use of calculator		n	%	Mean (SE)	SD	Diff
During mathematics lessons	Yes, with unrestricted use	2049	42.59	401.99(4.31)	76.87	1,2: 8.62
	Yes, with restricted use	2535	53.13	393.37(4.02)	78.07	1,3: 5.34
	No	206	4.28	396.65(19.65)	81.10	2,3: -3.28
To Check answers	Every or almost every lesson	1017	22.19	413.95(6.62)	78.46	1,2: 26.18* 1,3: 21.27*
	About half the lesson	581	13.67	387.77(8.13)	78.99	1,4: 20.40
	Some lessons	2423	53.36	392.68(3.82)	76.22	2,3: -4.91 2,4: -5.78
	Never	503	10.78	393.55(11.85)	80.34	3,4: -0.87
To do routine computations	Every or almost every lesson	931	20.70	418.91(7.26)	79.12	1,2: 27.64*
	About half the lesson	715	15.75	391.27(6.41)	76.51	1,3: 30.77* 1,4: 19.34
	Some lessons	2087	48.85	388.14(4.12)	76.95	2,3: 3.13 2,4: -8.30
	Never	724	14.70	399.57(8.19)	76.37	3,4: -11.43
To solve complex problems	Every or almost every lesson	1594	34.91	406.34(5.97)	80.61	1,2: 9.83 1,3: 14.59*
	About half the lesson	761	15.68	396.51(6.56)	75.18	1,4: 32.43
	Some lessons	2029	45.43	391.75(3.15)	74.86	2,3: 4.76 2,4: 22.60
	Never	182	3.98	373.91(30.46)	90.14	3,4: 17.84
To explore number concepts	Every or almost every lesson	906	18.96	414.64(7.64)	81.22	1,2: 30.90* 1,3: 19.27*
	About half the lesson	526	11.07	383.74(5.05)	75.01	1,4: 31.87*
	Some lessons	2722	61.57	395.37(3.62)	76.20	2,3: -11.63 2,4: 0.97
	Never	378	8.41	382.77(13.68)	80.67	3,4: 12.60

**Statistically significant at 5% level*

The results reveal that, generally, students are allowed to use calculators in Mathematics lessons, with 42.59% reporting unrestricted use, about 53% reporting restricted use and only about 4% reported no use. However, there is no significant difference in the performance of students in terms of the frequency they are allowed to use calculators, with means of 401.99, 393.37 and 396.65 for unrestricted use, restricted use, and no use, respectively.

The results further reveal that students who used calculators every or almost every lesson performed significantly higher than those who used calculators in some lessons or half of some lessons and never used calculators to check answers, do routine computations, solve complex problems, and explore number concepts.

The Use of Computers

The study investigated the effects of computer usage in Science and Mathematics lessons by students on their performance. The investigation included the availability of the computers for Science and Mathematics lesson, the quality of computers as well as the number of times such computers are used for different tasks. Table 5.17 presents the results.

Table 5.17: *The Use of Computers and Overall Performance in Science*

**Statistically significant at 5% level*

Use of computer		n	%	Mean (SE)	SD	Diff
Do students have computer(s) to use during class	Yes	681	13.48	407.11(8.63)	98.40	1,2: 4.80
	No	4398	86.52	402.31(4.15)	104.78	
Do any of the computer(s)have access to the internet	Yes	566	94.48	406.84(10.13)	99.91	1,2: 13.46
	No	41	5.52	393.38(4.42)	84.72	
Practice skills and procedures	Every or almost everyday	41	5.74	376.40(5.82)	113.47	1,2: -62.07* 1,3: 6.89 1,4: -22.14 2,3: 68.96* 2,4: 39.93* 3,4: -29.03*
	Once or twice a week	233	37.46	438.47(14.67)	86.53	
	Once or twice a month	35	9.54	369.51(7.57)	93.85	
	Never or almost never	291	47.26	398.54(10.90)	100.59	
Look up ideas and information	Every or almost every day	48	8.02	405.80(7.50)	93.81	1,2: -15.86 1,3: 0.40 1,4: 11.18 2,3: 16.26 2,4: 27.04 3,4: 10.78
	Once or twice a week	261	44.72	421.66(16.84)	96.30	
	Once or twice a month	105	17.18	405.40(22.94)	102.66	
	Never or almost never	186	30.08	394.62(12.91)	99.08	
Do scientific procedures or experiments	Every or almost every day	226	35.18	435.80(16.87)	91.90	1,2: 65.66* 1,3: 38.43* 2,3: -27.23*
	Once or twice a month	35	5.25	370.14(6.05)	106.48	
	Never or almost never	339	59.57	397.37(9.14)	98.51	
Study natural phenomena through simulations	Every or almost every day	41	5.74	376.40(5.82)	113.47	1,2: -61.11* 1,3: -62.86* 1,4: -17.26 2,4: 43.85* 3,4: 45.60
	Once or twice a week	108	16.83	437.51(9.91)	78.97	
	Once or twice a month	125	20.63	439.26(31.47)	92.16	
	Never or almost never	326	56.79	393.66(10.00)	100.13	
Process and analyse data	Every or almost every day	41	5.74	376.40(5.82)	113.47	1,2: -44.47 1,3: -29.40* 1,4: -31.39* 2,3: 15.07 2,4: 13.08 3,4: -1.99
	Once or twice a week	145	27.76	420.87(23.77)	94.02	
	Once or twice a month	48	8.02	405.80(7.50)	93.81	
	Never or almost never	366	58.47	407.79(11.08)	99.20	

The Use of Computers for Practice Skills and Procedure

The students whose teachers indicated that they used computers for practice skills and procedure every day or almost every day were out-performed significantly by those whose teachers indicated that they used computers for practice skills and procedure once or twice a week. The mean performance of those whose teachers indicated that the used computers for practice skills and procedure once or twice a week is 438.47, while those whose teachers indicated they use computers for practice skills and procedure every day or almost every day have a mean performance of 376.40.

There is also a significance difference between students whose teachers indicated that they used computers for practice skills and procedure once or twice a week and those whose teachers indicated that they use computers for practice skills and procedure once or twice a month. The mean performance of whose teachers indicated that the used computers for practice skills and procedure once or twice a week is 438.47, while those whose teachers indicated they used computers for practice skills and procedure once or twice a month is 369.51.

Another significance difference was recorded between the performances of students whose teachers indicated that they used computers for practice skills and procedure once or twice a week and those whose teachers indicated that they never or almost never used computers for practice skills and procedure. The mean performance of those whose teachers indicated that they used computers for practice skills and procedure once or twice a week is 438.47, while those whose teachers indicated they never or almost never used computers for practice skills and procedure 407.79.

The Use of Computers to do Scientific Procedures or Experiments
The students whose teachers indicated that they used computer for scientific procedures or experiments every day or almost every day have significantly performed better than those whose teachers indicated that they used computers for scientific procedures or experiments once or twice a month. The mean performance of students whose teachers indicated that they used computers for scientific procedures or experiments every day or almost every day is 435, while that of students whose teachers indicated that they used computers for scientific procedures or experiments once or twice a month is 370.

Another recorded significance difference is between students whose teachers indicated that they used computers for scientific procedures or experiments every day or almost every day and those whose teachers indicated that they never or almost never used computers for scientific procedures or experiments. The mean performance of students whose teachers indicated that they used computers for scientific procedures or experiments' every day or almost every day is 435 while that of students whose teachers indicated that they never or almost never used computers for scientific procedures or experiments is 390.

The Use of Computers to Study Natural Phenomena through Simulations
There is a significance difference between the performances of students whose teachers indicated that they used computers to study natural phenomena through simulations every day or almost every day and those whose teachers indicated that they used computers to study natural phenomena through simulations once or twice a week. The mean performance of students whose teachers indicated that they used computers to study natural phenomena through simulations every day or almost every day is 376.40 while that of students whose teachers indicated that they used computers to study natural phenomena through simulations once or twice a week is 437.51.

There is also a significance difference between the performances of students whose teachers indicated that they used computers to study natural phenomena through simulations every day or almost every day and those whose teachers indicated that they used computers to study natural phenomena through simulations once or twice a month. The mean performance of students whose teachers indicated that they used computers to study natural phenomena through simulations every day or almost every day is 376.40 while that of students whose teachers indicated that they used computers to study natural phenomena through simulations once or twice a month is 439.26.

Another significance difference was recorded between the performances of students whose teachers indicated that they used computers to study natural phenomena through simulations once or twice a week and those whose teachers indicated that they never or almost never used computers to study natural phenomena through simulations. The mean performance of students whose teachers indicated that they used computers to study natural phenomena through simulations once or twice a week is 439.26, while that of students whose teachers indicated that they never or almost never used computers to study natural phenomena through simulations is 393.66.

The Use of Computers to Process and Analyse Data
There is a significance difference between the performances of students whose teachers indicated that they used computers to process and analyse data every day or almost every day and those whose teachers indicated that they used computers to process and analyse data once or twice a month. The mean performance of students whose teachers indicated that they used computers to process and analyse data every day or almost every day is

376.40, while that of students whose teachers indicated that they used computers to process and analyse data once or twice a month is 405.80.

Another significance difference was recorded between the performances of students whose teachers indicated that they used computers to process and analyse data every day or almost every day and those whose teachers indicated that they never or almost never use computers to process and analyse data. The mean performance of students whose teachers indicated that they used computers to process and analyse data every day or almost every day is 376.40, while that of students whose teachers indicated that they never or almost never used computers to process and analyse data is 407.79.

Table 5.18: *The Use of Computers and Overall Performance in Mathematics*
**Statistically significant at 5% level*

Use of computers		n	%	Mean (SE)	SD	Diff
Do students have computer(s) to use during class	Yes	624	12.72	392.51(5.33)	72.35	1,2: -5.72
	No	4143	87.28	398.23(2.90)	78.46	
Do any of the computer(s)have access to the internet	Yes	511	89.05	396.65(5.63)	72.04	1,2: 32.22*
	No	76	10.95	364.43(14.01)	66.56	
Explore Mathematics principles and concepts	Once or twice a week	74	11.32	416.66(6.21)	61.97	1,2: 27.46
	Once or twice a month	190	29.56	389.20(13.50)	77.35	1,3: 27.12*
	Never or almost never	360	59.13	389.54(5.82)	70.65	2,3: -0.34
Practice skills and procedures	Every or almost every day	108	16.93	390.60(20.27)	73.96	1,2: -3.67
	Once or twice a week	196	30.36	394.27(10.78)	73.21	1,3: -1.51
	Once or twice a month	320	52.71	392.11(6.01)	71.25	2,3: 2.16
Look up ideas and information	Once or twice a week	41	5.81	417.12(5.89)	69.35	1,2: 28.00*
	Once or twice a month	301	47.14	389.12(8.92)	72.56	1,3: 24.25*
	Never or almost never	282	47.05	392.87(6.65)	71.85	2,3: -3.75
Process and analyse data	Once or twice a week	41	5.81	417.12(5.89)	69.35	1,2: 62.05*
	Once or twice a month	107	15.63	355.07(11.94)	69.68	1,3: 18.98*
	Never or almost never	476	78.56	398.14(4.88)	70.58	2,3:-43.07*

Some of the Computers have Internet Access
There is a significance difference between the performances of students whose teachers indicated that their computers have internet access and those whose teachers indicated that their computers have no internet access. The mean performance of students whose teachers indicated that their computers have internet access is 396.65, while that of students whose teachers indicated that their computers have no internet access is 364.43.

The Use of Computers to Explore Mathematics Principles and Concepts
There is a significance difference between the performances of students whose teachers indicated that they used computers to explore Mathematics principles and concepts once or twice a week and those whose teachers indicated that they never or almost never used computers to explore Mathematics principles and concepts. The mean performance of students whose teachers indicated that they used computers to explore Mathematics principles and concepts once or twice a week is 416.66, while that of students whose teachers indicated that they never or almost never used computers to explore Mathematics principles and concepts is 389.54.

The Use of Computers to Look for Ideas and Information
There is a significance difference between the performances of students whose teachers indicated that they used computers to search for ideas and information once or twice a week and those whose teachers indicated that they used computers to search for ideas and information once or twice a month. The mean performance of students whose teachers

indicated that they used computers to search for ideas and information once or twice a week is 417.12, while that of students whose teachers indicated that they used computers to search for ideas and information once or twice a month is 389.12.

Another significance difference was recorded between the performances of students whose teachers indicated that they used computers to search for ideas and information once or twice a week and those whose teachers indicated that they never or almost never used computers to search for ideas and information. The mean performance of students whose teachers indicated that they used computers to search for ideas and information once or twice a week is 417.12, while that of students whose teachers indicated that they never or almost never used computers to search for ideas and information is 392.87.

The Use of Computers to Process and Analyse Data
There is a significance difference between the performance of students whose teachers indicated that they used computers to process and analyse data once or twice a week and those whose teachers indicated that they used computers to process and analyse data once or twice a month. The mean performance of students whose teachers indicated that they used computers to process and analyse data once or twice a week is 417.12, while that of students whose teachers indicated that they used computers to process and analyse data once or twice a month is 355.07.

Another significance difference was recorded between the performance of students whose teachers indicated that they used computers to process and analyse data once or twice a week and those whose teachers indicated that they never or almost never used computers to process and analyse data. The mean performance of students whose teachers indicated that they used computers to process and analyse data once or twice a week is 417.12 while that of students whose teachers indicated that they never or almost never used computers to process and analyse data is 398.14.

Time of Content Coverage for each Main Topic in Mathematics and Science

The study investigated the relationship between the time of content coverage in Science and Mathematics and the performance on these contents. The findings are presented in Tables 5.19 and 5.20

Table 5.19: *Time of Content Coverage for each Main Topic in Science*

Content	Coverage	n	%	Mean (SE)	SD	Diff
Biology	Mostly taught before this year	375	7.23	412.45(14.25)	103.71	1,2: 8.25
	Mostly taught this year	4489	87	404.20(4.06)	104.21	1,3: 24.84
	Not yet taught or just introduced	303	5.77	387.61(8.24)	98.75	2,3: 16.59
Chemistry	Mostly taught before this year	28	0.62	411.66(7.48)	79.12	1,2: 0.86
	Mostly taught this year	955	18.34	410.80(8.23)	104.82	1,3: 8.29
	Not yet taught or just introduced	4111	81.04	403.37(4.02)	103.32	2,3: 7.43
Physics	Mostly taught before this year	566	11.05	405.52(11.82)	105.11	1,2: 0.28
	Mostly taught this year	4356	84.69	405.24(4.19)	103.71	1,3: 19.52
	Not yet taught or just introduced	214	4.26	385.98(5.82)	89.49	2,3: 19.26*
Earth Science	Mostly taught before this year	18	0.06	538.09(11.57)	54.32	1,2: 132.20*
	Mostly taught this year	1297	25.85	405.89(7.61)	103.12	1,3: 134.25*
	Not yet taught or just introduced	3821	74.09	403.84(4.33)	103.42	2,3: 3.05

**Statistically significant at 5% level*

The Time when Earth Science was Taught

There is a significance difference between the performance of students whose teachers indicated that Earth Science was mostly taught before this year and those whose teachers indicated that Earth Science was mostly taught this year. The mean performance of students whose teachers indicated that Earth Science was mostly taught before this year is 538.09, while that of students whose teacher indicated Earth Science was mostly taught this year is 405.89.

Another significance difference was recorded between the performance of students whose teachers indicated that Earth Science was mostly taught before this year and those whose teachers indicated that Earth Science was not yet taught or just introduced. The mean performance of students whose teachers indicated that Earth Science was mostly taught before this year is 538.09, while that of students whose teachers indicated that Earth Science was not yet taught or just introduced is 403.84. There were no significance differences on performance for different levels of content taught for Biology, Chemistry and Physics.

Table 5.20: *Time of Content Coverage for each Main Topic in Mathematics*

Content	Coverage	n	%	Mean (SE)	SD	Diff
Numbers	Mostly taught before this year	4131	84.49	397.49(2.90)	77.82	1,2: 0.71
	Mostly taught this year	666	14.04	396.78(8.97)	80.07	1,3: 22.53*
	Not yet taught or just introduced	75	1.47	374.96(4.14)	70.42	2,3: 21.82*
Algebra	Mostly taught before this year	503	10.14	404.05(8.32)	75.11	1,2: 6.13
	Mostly taught this year	4047	83.45	397.92(3.08)	77.85	1,3: 29.22
	Not yet taught or just introduced	322	6.41	374.83(12.77)	81.91	2,3: 23.09
Geometry	Mostly taught before this year	641	13.19	396.10(6.93)	74.54	1,2: -1.15
	Mostly taught this year	3827	78.56	397.25(3.40)	79.15	1,3: -0.67
	Not yet taught or just introduced	404	8.26	396.77(9.45)	73.29	2.3: 0.48
Data and Change	Mostly taught before this year	356	6.91	399.17(6.51)	74.49	1,2: 1.10
	Mostly taught this year	3681	77.06	398.07(3.02)	78.31	1,3:7.90
	Not yet taught or just introduced	835	16.03	391.27(6.56)	78.26	2,3: 6.80

**Statistically significant at 5% level*

The Time when Number was Taught

There is a significance difference between the performance of students whose teachers indicated that number was mostly taught before this year and those whose teachers indicated that number was not yet taught or just introduced. The mean performance of students whose teachers indicated that number was mostly taught before this year is 397.49, while that of students whose teachers indicated number was not yet taught or just introduced is 374.96.

Another significance difference was recorded between the performance of students whose teachers indicated that number was mostly taught this year and those whose teachers indicated that number was not yet taught or just introduced. The mean performance of students whose teachers indicated that number was mostly taught this year is 396.78, while that of students whose teachers indicated that number was not yet taught or just introduced is 374.96. There were no significance differences on performance for different levels of content taught for algebra, geometry and data and change.

Frequency of Engaging Students with Different Learning Activities

Teachers were asked to state the frequency with which they engaged students in certain activities that could enhance their learning. They were asked a set of questions which include: how often do you assign home work to the students; how many minutes do you usually assign for homework; how often do you correct assignments and give feedback to students; how often do you discuss the assignment in class; and, how often do you monitor whether the homework was completed. The results are show in Tables 5.21 and 5.22 for Mathematics and Science, respectively.

Table 5.21: *Homework Assignments and Overall Performance in Science*

	Frequency	n	%	Mean (SE)	SD	Diff
How often do you assign homework to the students	No homework assignment	38	0.74	408.37(8.65)	101.77	1,2: 28.85* 1,3: -3.59
	Less than once a week	789	16.44	379.52(10.01)	103.84	1,4: 11.29 1,5: 26.82
	1 or 2 times a week	3161	66.79	411.96(4.72)	103.66	2,3: -32.44* 2,4: -17.56
	3 to 4 times a week	592	13.30	397.08(7.51)	100.51	2,5: -2.03 3,4: 14.88
	Every day	144	2.72	381.55(28.71)	98.12	3,5: 30.41 4,5: 15,53
How many minutes do you usually assign for homework	15 minutes or less	868	19.20	387.94(9.52)	106.12	1,2: -17.20
	16-30 minutes	2578	52.61	405.14(5.15)	104.26	1,3: -29.29* 1,4: -9.99 1,5: -8.61
	31-60 minutes	876	18.41	417.23(9.07)	99.23	2,3: -12.09 2,4: 7.21
	61-90 minutes	104	2.20	397.93(37.24)	96.01	2,5: 8.59 3,4: 19.30
	More than 90 minutes	410	7.58	396.55(9.21)	105.00	3,5: 20.68 4,5: 1.38
Monitoring homework assignment	Always or almost always	2264	44.63	405.99(5.34)	103.96	1,2: 4.40
	Sometimes	2844	55.37	401.59(5.15)	103.97	

**Statistically significant at 5% level*

The Number of Times Teachers Assign Homework to Students

There is a significance difference between the performance of students whose teachers indicated that they never assign homework to students and those whose teachers indicated that they assign homework less than once a week. The mean performance of students whose teachers indicated that they never assign homework to students is 408.37, while that of students whose teachers indicated that they assign homework less than once a week is 379.52. There were no significance differences on performance for other different number of times of homework assignments.

The Homework Time in Minutes

There is a significance difference between the performance of students whose teachers indicated that they assigned homework time of 15 minutes or less to students and those whose teachers indicated that they assigned homework time of 31-60 minutes to students. The mean performance of students whose teachers indicated that they assigned homework time of 15 minutes or less to students is 387.94, while that of students whose teachers indicated that they assigned homework time of 31-60 minutes to students is 417.23. There were no significance differences on performance for other different time intervals of homework assignments.

Table 5.22: *Homework Assignments and Overall Performance in Mathematics*

	Frequency	n	%	Mean (SE)	SD	Diff
How often do you assign homework to the students	Less than once a week	31	0.69	376.65(12.77)	79.11	1,2: -14.42 1,3: -17.35 1,4: -24.12 2,3: -3.07 2,4: -9.70 3,4: -6.77
	1 or 2 times a week	734	15.43	391.17(6.18)	74.84	
	3 to 4 times a week	1683	36.30	394.10(5.31)	79.10	
	Every day	2226	47.58	400.87(4.51)	78.39	
How many minutes do you usually assign for homework	15 minutes or les	875	19.19	397.19(5.03)	76.95	1,2: 3.12 1,3: -2.37 1,4: -7.51 1,5: -1.23 2,3: -5.49 2,4: -10.63 2,5: -4.35 3,4: -5.14 3,5: 1.14 4,5: 6.28
	16-30 minutes	2277	49.42	394.07(4.09)	76.46	
	31-60 minutes	1024	22.13	399.56(7.86)	81.28	
	61-90 minutes	267	6.00	404.70(14.65)	81.87	
	More than 90 minutes	171	3.26	398.42(10.86)	72.97	
Correct assignments and give feedback to students	Always or almost always	4194	87.32	397.64(2.99)	78.59	1,2: 11.05
	Sometimes	578	12.68	386.59(5.32)	74.81	
Have students correct their own homework	Always or almost always	1441	30.04	402.34(4.65)	75.79	1,2: 9.44 1,3: 7.00 2,3: -2.44
	Sometimes	2451	51.79	392.90(4.33)	81.44	
	Never or almost never	838	18.18	395.34(4.42)	72.28	
Discuss the homework in class	Always or almost always	3527	74.15	395.66(3.26)	77.14	1,2: -2.74 1,3: 13.60* 2,3: 16.34*
	Sometimes	1212	25.07	398.40(5.10)	81.47	
	Never or almost never	33	0.78	382.06(3.95)	68.52	
Monitor whether or not the homework was completed	Always or almost always	4394	92.89	397.29(2.84)	78.00	1,2:13.20
	Sometimes	352	7.11	384.09(8.88)	80.16	
Use the homework to contribute towards students' grades or marks	Always or almost always	764	15.55	404.93(7.79)	78.49	1,2: 8.90 1,3: 10.60 2,3: 1.70
	Sometimes	1184	26.16	396.03(6.51)	79.36	
	Never or almost never	2721	58.28	394.33(3.56)	78.00	

**Statistically significant at 5% level*

In Mathematics, it is surprising that there seems to be no association between the regularity of giving assignments to students and performance. Generally most students are taught by teachers who give assignments on regular basis. Even the monitoring of assignments is more frequent (Always or almost always) has higher frequencies.

Teacher Emphasis of Different kinds of Assessment Methods and Students' Performance in Mathematics and Science

Teachers were asked to respond to the extent they emphasize on a number of assessment methods. Such methods include; evaluation of student on-going work, classroom tests, and national or regional achievement tests. The results are summarized in Table 5.23.

Table 5.23: *Teacher Emphasis of Different Kinds of Assessment Methods and Students' Performance in Mathematics and Science*

		n	%	Mean (SE)	SD	Diff
Mathematics						
Evaluation of student on going work	Major emphasis	4013	83.62	398.59(3.06)	77.78	1,2: 8.06
	Some emphasis	735	15.63	390.53(4.93)	74.07	1,3: 112.55*
	Little or no emphasis	35	0.75	286.04(3.71)	60.90	2,3 104.39*
Classroom tests	Major emphasis	3757	78.38	396.69(3.28)	78.62	1,2: 1.21
	Some emphasis	988	20.77	395.48(4.56)	74.39	1,3: -5.49
	Little or no emphasis	38	0.86	402.18(5.12)	77.33	2,3: -6.70
National or regional achievement tests	Major emphasis	2929	63.55	394.93(3.56)	76.95	1,2: -4.54
	Some emphasis	1353	28.40	399.47(5.53)	76.53	1,3: -11.17
	Little or no emphasis	371	8.05	406.10(9.17)	76.55	2,3: -6.63
Science						
Evaluation of student's on-going , work	Major emphasis	3603	68.70	402.78(4.37)	102.93	1,2: -5.24
	Some emphasis	1471	28.54	408.02(8.21)	104.80	1,3: 27.63
	Little or no emphasis	135	2.77	375.15(31.11)	110.88	2,3: 32.87
Classroom tests	Major emphasis	3935	75.15	406.76(4.50)	103.92	1,2: 13.31
	Some emphasis	1234	24.25	393.45(7.21)	103.34	1,3: 3.75
	Little or no emphasis	40	0.61	403.01(8.77)	84.27	2,3: -9.56
National or regional achievements tests	Major emphasis	3308	63.78	403.22(4.85)	103.90	1,2: -0.16
	Some emphasis	1536	29.45	403.38(5.91)	102.03	1,3: -3.62
	Little or no emphasis	365	6.77	406.84(17.71)	110.58	2,3: -3.46

**Statistically significant at 5% level*

The Evaluation of Students' On-going Work

There is a significance difference between the performance of students whose teachers indicated that they put major emphasis on the evaluation of students' on-going work and those whose teachers indicated that they put little or no emphasis on the evaluation of students' on-going work. The mean performance of students whose teachers indicated that they put major emphasis on the evaluation of students' on-going work is 398.59, while that of students whose teachers indicated that they put little or no emphasis on the evaluation of students' on-going work is 286.04.

Another significant difference between the performances of students whose teachers indicated that they put some emphasis on the evaluation of students' on-going work and those whose teachers indicated that they put little or no emphasis on the evaluation of students' on-going work. The mean performance of students whose teachers indicated that they put some emphasis on the evaluation of students' on-going work is 390.53, while that of students whose teachers indicated that they put little or no emphasis on the evaluation of students' on-going work is 286.04.

Other forms of monitoring students 'performance by teachers such as classroom tests, national and regional tests did not yield significant differences in student performance between themselves, neither did they show significant difference with the evaluation of students' on-going work. For Science, no significance difference was recorded between all forms of monitoring students' performance by teachers.

Regularity of Classroom Test or Examination

The study also investigated the regularity of classroom test or examination and the overall student performance for both Science and Mathematics. The results are summarized in Table 5.24.

Table 5.24: *Regularity of Classroom Test or Examination and Overall Performance in Mathematics and Science*

Subject	Frequency of testing	n	%	Mean (SE)	SD	Diff
Mathematics	About once a week	182	3.71	394.67(6.74)	70.66	1,2: -24.44 1,3: 0.58 1,4: -10.97 2,3: 25.02* 2,4: 14.17 3,4: -10.85*
	About every two weeks	578	11.81	419.11(10.65)	86.52	
	About once a month	4074	83.78	394.09(2.60)	76.45	
	A few times a year	42	0.70	404.94(2.40)	65.81	
Science	About once a week	251	5.72	426.15(14.23)	98.14	1,2: 18.69 1,3: 24.01 1,4: 52.85* 2,3: 5.32 2,4: 34.16* 3,4: 28.84*
	About every two weeks	632	11.90	407.46(10.01)	105.31	
	About once a month	4072	81.92	402.14(4.27)	103.88	
	A few times a year	34	0.46	373.30(5.07)	95.40	

**Statistically significant at 5% level*

The majority of the students are given examinations about once a month (83.78% and 81.92% for Mathematics and Science, respectively). In Mathematics, students who are given examinations about every two weeks have higher mean scores than all others, but interestingly, the difference is only significant when compared to those given examinations about once a month. On the other hand, in Science, students who are given examinations about once a week have higher mean scores compared to all others, but the difference is significant only with those given examinations a few times a year. In fact, all other students have higher mean scores than those students given examinations a few times a year, and the differences are significant in all instances.

Frequency of Including Certain Types of Questions in Tests in Mathematics and Science

Teachers were asked how often they included certain types of questions in Mathematics and Science tests. In Mathematics, such questions included: questions based on recall of facts and procedures; questions involving application of Mathematical procedures; questions involving searching for patterns and relationships; and, questions requiring explanations or justifications. For Science, the questions included: questions based on knowing facts and concepts; questions based on the application of knowledge and understanding; questions involving developing hypotheses and designing scientific investigations; and, questions requiring explanations or justifications. The results are summarized in Tables 5.25.

Table 5.25: *Frequency of Questioning in Mathematics Test and Students Performance*

Question Type	Frequency of question type	n	%	Mean (SE)	SD	Diff
Questions based on recall of facts and procedures	Always or almost always	3171	65.56	399.87(3.40)	79.31	1,2: 11.23*
	Sometimes	1497	32.90	388.64(4.45)	74.96	1,3: -8.15
	Never or almost never	68	1.54	408.02(28.75)	68.79	2,3: -19.38
Questions involving application of mathematical procedures	Always or almost always	4045	83.26	399.22(3.35)	78.88	1,2: 14.43*
	Sometimes	709	16.06	384.79(5.90)	74.05	1,3: 10.98
	Never or almost never	38	0.68	388.24(4.82)	71.34	2,3: -3.45
Questions involving searching for patterns and relationships	Always or almost always	2104	41.56	400.43(4.93)	79.22	1,2: 6.82
	Sometimes	2622	56.96	393.61(3.61)	76.89	1,3: 11.90
	Never or almost never	75	1.48	388.53(4.86)	76.36	2,3: 5.08
Questions requiring explanations or justifications	Always or almost always	1144	23.60	405.39(8.00)	82.80	1,2: 11.56
	Sometimes	3393	70.48	393.83(2.97)	76.22	1,3: 14.78
	Never or almost never	264	5.92	390.61(10.14)	75.40	2,3: 3.22

**Statistically significant at 5% level*

The Use of Questions Based on Recall of Facts and Procedures

There is a significance difference between the performance of students whose teachers indicated that they always or almost always used questions based on recall of facts and procedures and those whose teachers indicated that they sometimes used questions based on recall of facts and procedures. The mean performance of students whose teachers indicated that they always or almost always used questions based on recall of facts is 399.87, while that of students whose teachers indicated that they sometimes used questions based on recall of facts is 388.64.

The Use of Questions Involving Application of Mathematical Procedures

There is a significance difference between the performance of students whose teachers indicated that they always or almost always used questions involving the application of Mathematical procedures and those whose teachers indicated that they sometimes used questions involving the application of Mathematical procedures as shown in Table 5.26. The mean performance of students whose teachers indicated that they always or almost always used questions involving the application of Mathematical procedures is 399.22, while that of students whose teachers indicated that they sometimes used questions involving the application of Mathematical procedures is 384.79.

Table 5.26: *Frequency of Questioning in Science Test and Students' Performance*

Question Type	Frequency of question type	n	%	Mean (SE)	SD	Diff
Questions on knowing facts and concepts	Always or almost always	3797	73.53	403.85(4.15)	103.47	1,2: 4.63
	Sometimes	1277	25.12	399.22(8.25)	104.89	1,3: -27.57
	Never or almost never	78	1.35	431.42(13.72)	98.86	2,3: -32.20*
Questions on application of knowledge & understanding	Always or almost always	3841	74.74	409.15(4.29)	102.15	
	Sometimes	1311	25.26	385.04(7.53)	106.66	1,2: 24.11*
Questions on developing hypotheses and designing scientific investigations	Always or almost always	821	15.00	402.95(6.05)	99.49	1,2: -2.66
	Sometimes	3806	75.03	405.61(4.58)	102.66	1,3: 18.92
	Never or almost never	525	9.98	384.03(16.62)	116.30	2,3: 21.58
Questions requiring explanations or justifications	Always or almost always	3206	61.77	398.41(4.76)	103.20	1,2: -12.01
	Sometimes	1904	37.56	410.42(6.68)	104.46	1,3: -20.82*
	Never or almost never	42	0.67	419.23(8.42)	101.05	2,3: -8.81

**Statistically significant at 5% level*

The Use of Questions Based on Knowing Facts and Concepts
There is a significance difference between the performance of students whose teachers indicated that they never or almost never used questions based on knowing facts and concepts and those whose teachers indicated that they sometimes used questions based on knowing facts and concepts. The mean performance of students whose teachers indicated that they never or almost never used questions based on knowing facts and concepts is 431.42, while that of students whose teachers indicated that they sometimes used questions based on knowing facts and concepts is 399.22.

The Use of Questions on the Application of Knowledge and Understanding
There is a significance difference between the performance of students whose teachers indicated that they always or almost always used questions on the application of knowledge and understanding and those whose teachers indicated that they sometimes used questions on the application of knowledge and understanding. The mean performance of students whose teachers indicated that they always or almost always used questions on the application of knowledge and understanding is 409.15, while that of students whose teachers indicated that they sometimes used questions on the application of knowledge and understanding is 385.04.

The Use of Questions Requiring Explanations or Justifications
There is a significance difference between the performances of students whose teachers indicated that they always or almost always used questions requiring explanations or justifications and those whose teachers indicated that they never or almost never used questions requiring explanations or justifications. The mean performance of students whose teachers indicated that they always or almost always used questions requiring explanations or justifications is 398.41, while that of students whose teachers indicated that they never or almost never used questions requiring explanations or justifications is 419.23.

Teacher Participation in Professional Development Activities

The study also investigated the participation of teachers in professional development and the overall student performance for both Science and Mathematics. Teachers were asked as to whether they had participated in professional development activities, which included: content development; pedagogy/instruction development; curriculum development; integrating information technology; assessment methods development; and, addressing individual students' needs. The results are summarized in Table 5.27.

Table 5.27: *Teacher Participation in Professional Development Activities and Students' Performance in Mathematics and Science*

Activity attended		n	%	Mean (SE)	SD	Diff
Mathematics						
Mathematics content	Yes	1144	23.74	393.30(5.32)	77.14	1,2: -4.10
	No	3590	76.26	397.40(3.10)	78.24	
Mathematics pedagogy/instruction	Yes	1407	29.68	389.97(5.81)	77.94	1,2: -10.23
	No	3294	70.32	400.20(3.15)	77.60	
Mathematics curriculum	Yes	2052	42.01	395.06(4.18)	76.87	1,2: -2.62
	No	2719	57.99	397.68(3.42)	78.65	
Integrating information technology into mathematics	Yes	940	20.00	393.92(8.33)	80.79	1,2: -4.21
	No	3792	80.00	397.43(3.01)	77.33	
Improving students critical thinking or problem solving skills	Yes	1334	28.66	393.22(6.91)	80.59	1,2: -4.91
	No	3398	71.34	398.13(2.94)	76.96	
Mathematics assessment	Yes	1382	28.04	397.39(4.76)	76.43	1,2: 0.92
	No	3350	71.96	396.47(3.46)	78.67	
Addressing individual student's needs	Yes	1522	32.93	393.67(6.20)	79.19	1,2: -2.93
	No	3147	67.07	396.60(3.13)	76.36	
Science						
Science content	Yes	1240	23.71	404.17(8.51)	104.43	1,2: 0.62
	No	3896	76.29	403.55(4.23)	103.26	
Science pedagogy/instruction	Yes	1694	33.56	403.13(6.78)	102.99	1,2: -1.36
	No	3405	66.44	404.49(4.86)	103.72	
Science curriculum	Yes	1563	30.04	404.79(7.78)	103.52	1,2: 1.30
	No	3463	69.96	403.49(4.31)	103.63	
Integrating information technology into science	Yes	1038	19.59	403.29(9.08)	102.79	1,2: -0.93
	No	4061	80.41	404.22(4.09)	103.65	
Improving students critical thinking or inquiry skills	Yes	1529	28.74	406.39(6.29)	103.43	1,2: 3.77
	No	3607	71.26	402.62(4.63)	103.57	
Science assessment	Yes	1519	29.15	412.19(6.48)	99.45	1,2: 11.68
	No	3578	70.85	400.51(4.81)	105.04	
Addressing individual student's needs	Yes	1597	30.63	411.05(6.03)	101.87	1,2: 10.60
	No	3539	69.37	400.45(4.780	104.11	

**Statistically significant at 5% level*

Generally, the majority of the teachers do not participate in professional development activities. This was revealed by the high proportions of students who were taught by teachers who reported that they had not participated in professional development activities. The results further revealed that there is no significant difference in the performance of students according to whether their teachers have participated in professional development activities.

Teacher's Preparedness in Teaching Mathematics and Science

Knowledge of content is very critical in the teaching and learning of Mathematics and Science. The teachers were asked to respond to questions or statements that which, in the end, may indicate the level of preparedness of the teacher. The level of preparedness was divided into *Very well prepared*; *Somewhat prepared*; and, *Not well prepared*. In Mathematics, the questions cut across the entire Mathematics content area, that is, Number, Algebra, Geometry and Data and Chance. Each content area had sub questions. Whereas in Science, particular interest was on the four branches of Science: Biology, Chemistry, Physics and Earth Science. The results are displayed in Tables 5.28 and 5.29.

Teacher's Preparedness in Teaching Different Mathematics Topics and Students' Performance

The extent to which the teachers were prepared was to be associated with the way their students' performance in Number, Algebra, Geometry and Data & Chance. The state of preparedness is discussed below under the respective topics.

Table 5.28: *Teacher's Preparedness in Teaching Different Mathematics Topics and Students' Performance*

Content	Extent of preparedness	n	%	Mean (SE)	SD	Diff
Number	Very well prepared	4234	93.98	397.35(3.01)	78.43	1,2: 5.69
	Somewhat prepared	210	5.28	391.66(5.56)	71.91	1,3: -6.79
	Not well prepared	38	0.75	404.14(9.41)	60.54	2,3: -12.48
Algebra	Very well prepared	4446	94.69	398.15(2.89)	78.19	1,2: 25.15*
	Somewhat prepared	165	3.83	373.00(6.62)	74.63	1,3: 2.48
	Not well prepared	71	1.48	395.67(10.01)	67.64	2,3: -22.67
Geometry	Very well prepared	4407	93.43	398.14(2.86)	78.20	1,2: 7.88
	Somewhat prepared	236	5.10	390.26(11.87)	79.00	1,3: 2.47
	Not well prepared	71	1.47	395.67(10.01)	67.64	2,3: -5.41
Data and chance	Very well prepared	3373	85.54	400.26(2.94)	77.89	1,2: 18.85*
	Somewhat prepared	532	13.49	381.81(5.36)	71.01	1,3: -3.88
	Not well prepared	38	0.97	404.14(9.41)	60.54	2,3: -22.33*

**Statistically significant at 5% level*

Number

For Number, the questions that needed to be addressed were about computation, estimating or approximating whole numbers and fractions, decimals, representing, comparing and ordering. Others were involved with the use of percentages and proportions to solve problems. The respective mean scores of the students whose teachers indicated *Very well prepared*, *Somewhat prepared* and *Not well prepared* were 397.35, 391.66 and 404.14, but the differences showed no significance as measured by the standard error. And, even though the students whose teachers indicated that they were not well prepared had the highest mean score, they were not even 1% of the students, as such, there isn't much to report on them.

Algebra

This area exploited patterns and sequences of algebraic expressions, linear equations, functions as ordered pairs, simultaneous equations and inequalities. For Algebra, the standard error reports significance between the mean scores for the students whose teachers indicated *Very well prepared* and those whose teachers indicated *Somewhat prepared* but not for those whose teachers said *Not well prepared*.

Geometry

These included geometric properties of angles and geometric shapes, similarity and congruency, representations of 3-dimenstional (3D) figures in 2D. It also included perimeters, circumferences and areas, Cartesian coordinates and transformation up rotation.

The respective mean scores of the students whose teachers indicated *Very well prepared*, *Somewhat prepared* and *Not well prepared* differences showed no significance as measured by the standard error and just as in the case of Numbers, there isn't much to report on them.

Data and Chance
This module covers reading and displaying data in tabular, graph and chart forms. These include interpreting data by drawing conclusions and making predictions and, predicting and determining the chances of possible outcomes. For Data and Chance, the standard error reports significance between the mean scores for the students whose teachers indicated *Very well prepared* against those whose teachers indicated *Somewhat prepared* but not against those whose teachers said *Not well prepared*. Another standard error reports significance between the mean scores of those students whose teachers indicated *Somewhat prepared* against those whose teachers indicated *Not well prepared*. Again, those whose teachers indicated that they were not prepared sufficiently is less than 1%. Across the modules, it was clear that the teachers were prepared to teach the topics as more that 90% of the indicated so.

Teacher's Preparedness in Teaching Different Science Topics

Teachers were asked to respond to how well they are prepared to teach particular content domains in Science, which include; Biology, Chemistry, Physics, and Earth Science. Table 5.29 provides the summary of the results.

Table 5:29: *Teacher's Preparedness in Teaching Different Science Topics and Students' Performance*

Content	Extent of preparedness	n	%	Mean (SE)	SD	Mean Diff
Biology	Very well prepared	4350	94.12	402.56(4.22)	104.67	1,2: 2.32
	Somewhat prepared	273	5.88	400.24(9.70)	100.67	
Chemistry	Very well prepared	3006	90.42	407.11(5.20)	104.31	1,2: 28.36*
	Somewhat prepared	336	9.58	378.75(10.54)	100.45	
Physics	Very well prepared	4034	89.30	405.60(4.09)	103.01	1,2: 28.74*
	Somewhat prepared	446	10.70	376.86(11.22)	104.38	
Earth Science	Very well prepared	2154	76.80	400.02(5.04)	102.50	1,2: 6.78
	Somewhat prepared	658	21.77	393.24(11.59)	104.94	1,3: -1.81
	Not well prepared	43	1.43	401.83(108.91)	86.26	2,3: -8.59

**Statistically significant at 5% level*

The results reveal that in Biology, all the students were taught by teachers who reported to be at least somehow prepared to teach Biology (94%) very well prepared and about 6% somewhat prepared. There was, as such, no significant difference in the performance of students taught by teachers who were very well prepared and those who were somewhat prepared. In Chemistry also, more students were taught by teachers who were very well prepared compared to those who were somewhat prepared (90.42% and 9.58%, respectively). And, those students of very well prepared teachers performed significantly higher than those of somewhat prepared teachers with mean scores of 407.11 and 378.75, respectively. A similar pattern as in Chemistry is also observed in Physics. On the other hand, in Earth Science, although almost all students were taught by teachers who reported to be prepared, there is no significant difference in the performance of students according to the level of teacher preparedness.

Summary

As may be observed, the quality of teachers in terms of individual characteristics and professional dexterity go a long way in ensuring that quality education is provided to students, particularly at elementary level. However, the level of education of the teacher did not have any significant difference in the performance of the students as measured by the mean scores.

The study has shown that parental support, parental involvement, students' regard for school property and students' desire to do well in school had significant differences in the performance of students between those whose teachers indicated high, medium or low. This applied to the means scores in Mathematics and Science. The results also revealed that most students are taught by teachers who are concerned about the conditions or the school environment within which they work. As such, it affects the performance of the students. Where the students were crowded in classrooms, the performance of students had a significant difference in mean scores between those whose teachers said it was a problem and those who said it was not. The state of the classrooms was also a concern to the teachers because there was significant performance of the students whose teachers said it was a problem and those whose teachers said it wasn't.

Attitudes and behaviours of teachers towards their profession play a role in the performance of teachers, thus of the students. The more teachers are satisfied with their profession (general conditions within their profession), the higher the possibility of efficiency and effectiveness in teaching, thus the higher performance of the students, as shown in the results. General lack of resources, inadequate participation in professional development, lack of confidence and preparedness to teach certain content domains hamper teacher efficiency and effectiveness, consequently, affecting students' performance. As such, these issues need to be addressed for the betterment of the overall performance of students in examinations.

Recommendations

The recommendations that can be made from this chapter are:

1. The teachers need to be motivated so as to develop positive attitudes. This goes a long way in affecting the attitudes of the students as well. This research has also shown that the students' attitudes play an important role in their performance.

2. The role of parents is also important in the performance of students. Therefore it is important to engage parents in the education of students.

3. The accommodation of students in classrooms also affected the performance of students as indicated by the mean scores. It is necessary to look into the student numbers in the classrooms with a view of rationalising the numbers.

4. The schools should be equipped with material resources in order that the teachers can put them in good use to assist the students.

CHAPTER SIX

SCHOOL BACKGROUND VARIABLES AND STUDENTS' PERFORMANCE

The school heads for schools whose students were sampled to take part in the Trends in Mathematics and Science Study and Progress in International Reading and Literacy Survey were requested to fill a questionnaire which provided some background information on the schools regarding some of the variables. The information was mainly on: School Enrolment and Characteristics; Instructional Time; Resources and Technology; Involvement of Parents in School; School Climate; Teachers in School; Leadership Activities; School Readiness; and, Reading in School. The questions under each variable were analysed against the students' performance in Mathematics and Science.

School Enrolment and Characteristics

The school heads provided information on the total number of students in their schools. The numbers were grouped and each category was analysed against the performance of the students. The results are shown in Table 6.1.

Table 6.1: *School Enrolment and Students' Performance*

Enrolment	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
0-200	53	1.27	387.63 (8.10)	63.71	1,2:-2.39 1,3:-4.76	401.49 (10.72)	76.74	1,2:7.92 1,3:4.04
201-400	769	14.08	390.02 (6.32)	77.63	1,4:-15.50 1,5:3.41	393.56 (7.27)	103.64	1,4:-12.37 1,5:12.71
401-600	1 639	29.7	392.38 (5.31)	78.71	1,6:-17.11 2,3:-2.37 2,4:-13.11	397.44 (6.66)	104.39	1,6:-18.92 2,3:-3.88 2,4:-20.29*
601-800	2 238	42.48	403.13 (2.93)	76.65	2,5: 5.80 2,6:-14.72 3,4:-10.74	413.86 (4.70)	102.7	2,5:4.78 2,6:-26.84 3,4:-16.41*
801-1000	390	8.84	384.22 (7.11)	75.13	3,5: 8.17 3,6: -12.35 4,5: 18.91*	388.78 (8.41)	105.09	3,5: 8.66 3,6: -22.96 4,5:25.08*
1001-1200	145	3.62	404.74 (21.89)	76.1	4,6: -1.61 5,6: -20.52	420.40 (29.24)	100.38	4,6:-6.55 5,6: -31.62

**Statistically significant at 5% level*

The majority of the sample had a total enrolment of 601 – 800 students followed by 401-600 categories. The performance of the students in both Mathematics and Science subjects is not influenced by the number of students per school. The performance was slightly lower for schools with a population of 801-1000. In both subjects, significant difference in means was observed between the 601-800 and 801-1000 categories.

Form Two School Enrolment and Students' Performance

The school heads also provided information on the number of Form Two students in the school. The number of students was categorised into six categories and each category was correlated with the performance of the students. Table 6.2 shows the performance of students by students' enrolment in standard 6.

Table 6.2: *Form Two School Enrolment and Students' Performance*

Enrolment	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
0-20	33	0.72	382.06(3.95)	68.52	1,2:-99.66* 1,3:-58.31 1,4:9.84 1,5:-0.58 1,6: -14.22* 2,3:41.36 2,4: 109.50* 2,5: 99.09* 2,6:85.44* 3,4:68.15 3,5: 57.73 3,6: 44.09 4,5:-10.42 4,6: -24.06* 5,6: -13.65	393.22(3.60)	89.2	1,2: -129.00* 1,3: -49.47 1,4: 5.35 1,5: 1.11 1,6: -10.68* 2,3: 79.58 2,4: 134.40* 2,5: 130.20* 2,6: 118.40* 3,4: 54.82 3,5: 50.58 3,6: 38.79 4,5: -4.23 4,6: -16.03* 5,6: -11.80
21-40	34	0.11	481.73(4.87)	52.64		522.26(4.73)	57.56	
41-60	47	1.15	440.37(98.06)	94.06		442.68(100.97)	113.58	
61-80	20	0.61	372.22(6.83)	53.58		387.87(7.29)	76.11	
81-100	122	2.59	382.6(11.51)	74.11		392.10(15.69)	95.57	
100+	4 978	94.83	396.29(2.49)	77.22		403.90(3.68)	103.85	

**Statistically significant at 5% level*

The majority of the students in junior secondary schools (94.83%) were from schools which had Form Two enrolment of 100+ students. The other categories had very low percentages.

Economic Background and Students' Performance

The school heads also provided information on the approximate percentage of students in the school whom he/she thought were economically disadvantaged or economically affluent. The performance of students in both Mathematics and Science by level of economic background is shown in Table 6.3.

Table 6.3: *Economic Background and Performance of Students*

	Proportion	n	%	Mathematics			Science		
				Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Disadvantaged	0 - 10%	358	7.2	432.43(13.69)	78.07	1,2: 14.74 1,3; 31.97* 1,4: 52.61* 2,3; 17.23* 2,4: 37.87* 3,4: 20.65*	450.32(16.53)	93.7	1,2: 18.55 1,3: 40.67* 1,4: 67.59* 2,3: 22.13* 2,4: 49.04* 3,4: 26.91*
	11 - 25%	821	15.5	417.69(7.16)	76.69		431.78(9.00)	99.18	
	26 - 50%	1 499	29.32	400.46(3.45)	71.94		409.65(5.22)	97.92	
	>50%	2 536	47.98	379.81(2.82)	75.37		382.73(4.37)	103.68	
Affluent	0 - 10%	2 323	49.36	383.75(3.10)	75.71	1,2: -11.18 1,3: -26.32* 1,4: -38.26* 2,3: -15.15 2,4: -27.08 3,4: -11.93	387.94(4.35)	103.1	1,2: -15.40 1,3: -35.99* 1,4: -46.37* 2,3: -20.59 2,4: -30.97 3,4: -10.38
	11 - 25%	1 059	22.39	394.93(5.74)	75.51		403.34(8.40)	103.75	
	26 - 50%	753	17.03	410.07(8.08)	76.78		423.93(10.10)	101.06	
	>50%	518	11.22	422.0 1(12.95)	82.04		434.30(16.08)	102.89	

**Statistically significant at 5% level*

The majority of the students were from economically disadvantaged background. Most of the students (77.3%) were from schools where school heads felt that more than 26% of the students were economically disadvantaged. The performance of the students in both subjects was affected by their economic status. The performance of students varies by the proportion of disadvantaged students in schools. Schools with larger proportions of disadvantaged students performed poorly compared to schools with small proportions of disadvantaged students. The performance difference between levels of disadvantaged proportions is statistically significant.

Percentage of Students who had English as a Native Language and Their Performance in Mathematics and Science

School heads provided information on the percentage of students in their schools with English as their native language. English is an official language in Botswana, but very few students in Botswana have English as their native language. The results of English as native language against students' performance are summarised in Table 6.4.

Table 6.4: *Percentage of Students who had English as Native Language and Their Performance in Mathematics and Science*

Proportion of students	n	%	Mathematics			Science		
			Mean (se)	SD	Diff	Mean(se)	SD	Diff
> 90%	177	4.01	371.35(6.66)	71.01	1,2:-150.80* 1,3: -180.60*	376.94(11.12)	101.66	1,2; -150.10* 1,3: -211.40*
76 - 90%	18	0.71	522.26(4.17)	53.4	1,4: -24. 55* 2,3: -29.67*	527.01(5.66)	52.05	1,4: -26.39* 2,3: -61.30*
51 - 75%	20	0.51	551.94(4.88)	44.5	2,4;126.40*	588.30(4.75)	42.47	2,4: 123.70*
< 25%	4 768	94.78	395.89(2.38)	75.74	3,4: 156.00*	403.33(3.64)	102.02	3,4:185.00*

**Statistically significant at 5% level*

The majority of the students sampled (94.78%) did not have English as their native language. The other three categories had very few students with each category having a percentage lower than 5.

Locality and Average Income of the Area and Students' Performance

Another category which was looked at was the locality of the school. This involved variables such as the population of the area, the description of the area where the school is located and the average income level of the area where the school is located. Table 6.5 below shows the performance of the students in relation to the type of locality of the school they were attending.

Table 6.5: *Performance by School Locality and Average Income of the Area*

Locality	n	%	Mathematics			Science		
			Mean (SE)	SD	Diff	Mean (SE)	SD	Diff
Urban	553	11.28	436.49(10.35)	78.88	1,2: 34.81* 1,3: 4.11	459.88(11.76)	94.64	1,2: 40.76* 1,3: 2.86
Suburban	468	8.84	401.67(5.18)	69.9	1,4: 43.71* 1,5: 59.78* 2,3:-30.70*	419.12(7.42)	92.69	1,4: 60.93* 1,5: 85.85* 2,3:-37.90*
Large Town	197	4.18	432.38(7.22)	68.32	2,4: 8.90 2,5: 24.96*	457.03(8.63)	88.21	2,4:20.17* 2,5: 45.09*
Village	2 668	51.95	392.77(3.30)	75.99	3,4: 39.60* 3.5: 56.06	398.95(4.67)	102.96	3,4:58.07* 3,5: 83.00*
Remote Rural	1 310	23.75	376.71(3.72)	74.81	4.5: 16.06	374.03(4.67)	100.81	4.5: 24.92

**Statistically significant at 5% level*

The majority of the students (51.95%) were from schools in villages. The performance of the students in both subjects varied with the area in which the school was located. Students in urban areas performed better than students in towns. Those in large towns were better than students in suburban areas. The lowest performance in all the subjects was for students in remote rural areas.

Instruction Time and Performance of Students

Government schools in Botswana follow a standard calendar which is prepared by the Ministry of Education and Skills Development. The average number of school days available for instruction in a year is around 150. The number of days and hours available for Mathematics and Science instruction varies from school to school as it depends mainly on how the school plans its activities. While some schools follow the six day timetable, the actual number of days available for instruction per week is five. Table 6.6 shows the performance of students when analysed against the number of days available for instruction.

Table 6.6: Performance of Students by Instructional Time

Instruction time	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
6	1 015	18.87	388.68(5.07)	76.82	1,2: -93.05* 1,3: -8.35 1,4: -39.58* 1,5: -17.21* 2,3: 84.70* 2,4: 53.47* 2,5: 75.84* 3,4: -31.23* 3,5: -8.86 4,5: 22.37*	391.54(7.46)	103.18	1,2: -130.70* 1,3: -13.86 1,4: -67.62* 1,5: -18.69* 2,3: 116.90* 2,4: 63.11* 2,5: 112.00* 3,4: -53.75* 3,5: -4.83 4,5: 48.93*
5½	34	0.11	481.73(4.87)	52.64		522.26(4.73)	57.56	
5	3 991	78.78	397.03(3.13)	77.33		405.40(4.05)	103.73	
4½	38	0.73	428.26(4.16)	75.36		459.16(6.59)	96.31	
4	76	1.51	405.89(6.08)	77.13		410.23(4.34)	94.07	
other	1 015	18.87	388.68(5.07)	76.82		391.54(7.46)	103.18	

* *Statistically significant at 5% level*

As expected, most of the students (78.78%) are from schools which are open for instruction for 5 days. The other options have very low percentages of students.

Resources and Technology

Meaningful learning can only take place where students have unlimited resources available to them. Students should have an environment which is conducive to learning and allows them to explore their surroundings without any limits. Some of the resources which were looked at are: availability of computers for instructional purposes and their number, availability of a science laboratory and availability of a school library.

Availability of Computers and Students' Performance

Tables 6.7 and 6.8 show the performance of the students against the availability of different resources.

Table 6.7: *Availability of Computers and Students' Performance*

# of computers	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
0-10	620	11.35	406.05(7.53)	76.43	1,2: 15.76* 1,3: 8.54 1,4: -24.70 1,5: 1.66 1,6: 10.52 2,3: -7.21 2,4: -40.46* 2,5: -14.10 2,6: -5.25 3,4: -33.25* 3,5: -6.88 3,6: 1.97 4,5: 26.36 4,6: 35.22* 5,6:8.85	413.72(10.93)	102.42	1,2: 16.13 1,3: 9.79 1,4: -41.35* 1,5: -0.23 1,6: 15.71 2,3: -6.35 2,4: -57.48 2,5: -16.37 2,6: -0.425 3,4: -51.14 3,5: -10.02 3,6: 5.92 4,5: 41.12 4,6: 57.06* 5,6: 15.94
11-20	2 953	56.81	390.29(2.78)	75.95		397.59(4.27)	103.24	
21-30	486	8.83	397.50(9.67)	80.07		403.93(11.59)	105.31	
31-40	280	5.35	430.75(10.43)	81.01		455.07(11.99)	100.23	
41-50	260	5.37	404.39(11.74)	69.8		413.96(18.85)	92.43	
51+	635	12.29	395.53(9.11)	79.34		398.01(10.07)	104.46	

**Statistically significant at 5% level*

Most of the junior secondary schools have been provided with computers that can be used for instructional purposes. The number of the computers available varies from school to school. The computers are mainly used for the computer lessons and they are not used to aide Mathematics and Science learning, hence their availability in large will not have an impact on the performance of students in these subjects. However, there exists a statistical difference between students who come from schools with 11-20 computers and those with 0-10 computers. There is also significance difference between schools with 11-20 computers and those with 31-40 computers in both subjects.

Table 6.8: *Performance by Availability of Laboratory and Library for Science*

		n	%	Mean(SE)	SD	Diff
Laboratory	Yes	4 737	90.95	401.26 (3.60)	103.98 (1.86)	1,2: -30.00*
	No	449	9.05	431.25 (13.80)	97.39 (3.82)	
Library	Yes	2 474	47.91	409.83 (5.15)	103.26 (2.32)	1,2: 11.30
	No	*2 715*	*52.09*	*398.53 (4.84)*	*103.89 (2.49)*	

**Statistically significant at 5% level*

Science laboratories are supposed to be used to strengthen the delivery of the science content. Some science laboratories are not serving their purpose as they are used as normal classrooms. This tends to limit the time available for both students and teachers to carry out experiments in laboratories.

How Shortage or Inadequacy of Some Resources Affected Schools Capacity to Provide Instruction

The school heads were asked to indicate their views on how they feel about the shortage or inadequacy of some resources affecting the capacity of the school to provide instruction. Their views were condensed under three main sub headings namely: General School Resources, Resources for Mathematics Instruction and Resources for Science Instruction.

Inadequacy of Some Resources and Students' Performance

The general school resources were grouped into an index which was formed by: instructional materials (e.g. textbooks); supplies (e.g. papers, pencils); school buildings and grounds; heating/cooling and lighting systems; instructional space (e.g. classrooms); technology competent staff and computers for instruction. The performance of the students was analysed by the index and the results are as shown in Table 6.9.

Table 6.9: *Inadequacy of Some Resources and Students' Performance*

Resources' Inadequacy	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Not at all	78	1.44	421.39(13.27)	73.65	1,2: 24.23 1,3: 28.86* 1,4: 9.98 2,3: 4.62 2,4: -14.25 3,4: -18.87	438.51(18.35)	92.72	1,2: 32.65 1,3: 40.51* 1,4: 10.26 2,3: 7.87 2,4: -22.38 3,4: -30.25*
A little	1 740	33.78	397.16(5.91)	79.91		405.86(8.04)	107.66	
Somewhat	3 000	57.68	392.54(2.97)	75.85		397.99(4.29)	101.7	
A lot	371	7.11	411.41(10.03)	75.24		428.24(12.70)	96.81	

Statistically significant at 5% level

The majority of the students (57.68%) were from schools where the school head felt that the shortage or inadequacy of the resources somewhat affect the school's capacity to provide instruction. The performance of the students is lower where the school head felt the shortage or inadequacy of resources affected the school's capability a lot in both subjects.

For Mathematics resources, the index was: teachers with specialisation in Mathematics; computers for Mathematics instruction; computer software for Mathematics instruction; library materials relevant to Mathematics instruction; audio-visual resources for Mathematics instruction; and, calculators for Mathematics instruction. The results of the students' performance against the index are shown in Table 6.10.

Table 6.10: *Performance of the Students by Inadequacy of Mathematics Resources*

Resources' Inadequacy	n	%	Mean(SE)	SD	Diff
Not at all	39	0.57	357.37 (4.14)	68.69	1,2: -48.22* 1,3: -32.56* 1,4: -43.93* 2,3: 15.67* 2,4: 4.30 3,4: -11.37
A little	1 690	32.04	405.59 (6.35)	83.55	
Somewhat	2 794	55.18	389.93 (3.06)	73.9	
A lot	629	12.21	401.30 (6.52)	72.51	

**Statistically significant at 5% level*

For Science the index was constructed from: teachers with specialisation in Science; computers for science instruction; computer software for science instruction; library materials relevant to science instruction; audio-visual resources for science instruction; and science equipment and materials. The results of the students' performance against the index are shown in Table 6.11.

Table 6.11: *Performance of the Students by Inadequacy of Science Resources*

Resources' Inadequacy	n	%	Mean(SE)	SD	Diff
Not at all	208	3.29	420.31 (28.16)	118.4	1,2: 5.07* 1,3:23.56* 1,4: 20.63* 2,3: 17.85 2,4: 14.92 3,4:-2.93
A little	1 679	32.86	414.61 (8.26)	107.11	
Somewhat	2 497	48.66	396.76 (4.17)	100.09	
A lot	768	15.19	399.68 (8.62)	100.75	

*Statistically significant at 5% level

In both subjects, most of the students were from schools where the schools heads responded by saying, *a little* or *somewhat' affects* the capacity to deliver instruction. The views of the school heads do not seem to correlate with the performance of the students in both subjects.

Involving Parents in School

Parents play a big role in the development and overall learning, both informal and formal, of their children. Parents can greatly influence the way the children view their future, particularly when the children are not mature enough to make some independent decisions. For effective learning to take place, parents should be involved in one way or the other in the education of their children. Schools should also be willing to involve parents in the learning of their children and where possible, the parents should be actively involved in the learning of their children.

The Frequency at which School Informs Parents about Issues Concerning Students

It is important for school heads to work closely with parents for the betterment of students' achievements. In the study, school heads were requested to indicate how often they engaged with parents on issues concerning students, like students' learning progress, behaviour and well-being of students, parental support on schoolwork and parental concerns about students learning in general. For brevity, these four issues are collapsed into an index representing the rate at which the school heads informed parents about issues concerning students. The analyses associating the index with students performance is presented in Table 6.12.

Table 6.12: *Frequency at Which the School Informs Parents about Students' Issues and Students' Performance*

Frequency	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Once a year	3 289	63.6	395.39 (3.40)	77.44	1,2: -9.11* 1,3: 12.89* 2,3: 22	402.59 (4.55)	104.1	1,2: -13.17* 1,3: 18.76* 2,3: - 31.93
2-3 times a year	1 166	23.86	404.50 (5.46)	77.16		415.76 (6.97)	100.59	
> 3 times a year	697	12.55	382.50 (4.83)	76.2		383.83 (7.74)	105.44	

Statistically significant at 5% level

The majority of the school heads reported that they informed parents about the performance of the students once a year. The performance of the students was better in both subjects in cases where parents are informed 2-3 times a year about the students' performance. There are schools which are not giving any form of feedback to parents regarding the performance of their children.

The Frequency at which School Informs Parents about Issues Concerning Schools

School heads were also asked to indicate how often they informed parents about issues concerning the school. These issues include: informing parents about the overall academic achievements of the school; inform parents about school accomplishments in the tournaments; inform parents about the educational goals and pedagogical principles of the school; discuss parents' concerns or wishes about the school's organisation; provide parents with additional learning materials and organise workshops or seminars for parents on learning pedagogical issues. Table 6.13 shows the performance of the students when analysed against the frequency at which parents are informed about issues concerning the school.

Table 6.13: *Frequency at Which the School Informs Parents about Students' Issues and Students' Performance*

Frequency	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean (SE)	SD	Diff
Never	151	2.86	372.38(16.26)	79.31	1,2; -20.30	367.26 (19.20)	104.65	1,2: -31.75
once a year	3 412	66.67	392.68(3.38)	76.03	1,3: -29.44 1,4: -149.20*	399.01 (4.67)	103.11	1,3: -45.62* 1,4: -172.40*
2-3 times a year	1 492	30.03	401.83(4.43)	78.08	2,3: -9.15	412.88 (6.33)	102.79	2,3: -13.87
> 3 times a year	21	0.44	521.63(5.13)	68.77	2,4: -128.90* 3,4: -119.80*	539.64 (8.35)	72.37	2,4: -140.60* 3,4: -126.80*

**Statistically significant at 5% level*

Most of students (66.67%) went to schools where it was reported that the parents were informed about the students' issues of the school once a year. Even though informing parents might not have a direct impact on the performance, there is significant effect in performance when parents are informed frequently (2-3 times a year) compared to when they are never be informed.

School Climate

The school climate or school environment must be conducive for learners to fully benefit from their learning. The school climate is very complex and can be made uncomfortable to learners by a number of issues including interactions with other students, teacher behaviour and parental support. Currently, very few students leave school without completing their primary studies or are not able to perform to their full potential due to reasons related to school climate. There are a number of reforms which focused mainly on creating an environment which is conducive for learning. Some of the reforms include, reducing class sizes at primary school, and reviewing policies that have a negative effect on learning.

There were two major questions on school climate. The first question wanted the view of the school head on how he/she can characterise teachers' job satisfaction and their competency and understanding of school goals. It also wanted to find out the level at which parents are involved in the running of the school and students' regard for school property. The second question was to find out how problematic were issues like late coming, absenteeism, cheating, vandalism, theft, etc. in their schools amongst students and/or teachers.

Positive School Climate and Students' Performance

In this section, the students' performance in Mathematics and Science is associated with certain attributes that are usually necessary for students to do well. School heads were asked to indicate to what degree were these factors present in their school. The factors include the following: teachers' job satisfaction; teachers' degree of understanding and implementing the schools' curriculum; parental support of school activities; expectation of teachers on students' achievements; students' regard for school property; and, students high desire to do well in school. The results are presented in Table 6.14.

Table 6.14: *Positive School Climate and Students' Performance*

School climate		n	%	Mathematics			Science		
				Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Teachers' job satisfaction	High	529	10.59	418.51 (11.42)	84.46	1,2:25.24* 1,3: 25.47* 2,3: 0.22	431.71 (12.90)	108.48	1,2: 31.02* 1,3: 32.54* 2,3: 1.52
	Medium	2 619	50.32	393.27 (3.71)	76.62		400.69 (5.38)	104.01	
	Low	2 041	39.08	393.04 (3.63)	75.34		399.17 (5.29)	100.73	
Teachers' understanding of the school's curricula goals	High	3 010	58.1	398.22 (3.60)	78.32	1,2: 5.33 1,3: 8.23 2,3: 2.90	406.47 (4.80)	105.55	1,2: 7.92 1,3: 2.78 2,3: -5.14
	Medium	1 936	37.46	392.89 (3.90)	76.47		398.55 (5.68)	101.98	
	Low	243	4.44	389.98 (7.51)	71.4		403.69 (9.13)	91	
Teachers' degree of success in implementing the school curriculum	High	1 722	33.85	407.64 (5.61)	80.13	1,2: 15.00* 1,3: 36.59* 2,3: 21.59*	418.01 (7.61)	105.21	1,2: 18.58* 1,3: 45.67* 2,3: 27.09*
	Medium	2 996	57.51	392.64 (2.76)	75.01		399.43 (4.13)	101.87	
	Low	471	8.64	371.05 (7.37)	74.03		372.34 (8.71)	100.41	
Teachers' expectations for student achievement	High	2 747	52.01	404.11 (3.51)	77.63	1,2: 12.57* 1,3: 27.30* 2,3: 14.73*	414.10 (4.99)	103.06	1,2: 15.41 1,3: 37.40* 2,3: 21.99*
	Medium	1 624	32.88	391.55 (5.01)	76.26		398.69 (7.15)	103.16	
	Low	818	15.11	376.81 (4.89)	74.83		376.70 (6.47)	101.38	
Parental support for student achievement	High	506	9.84	423.49 (12.75)	81.26	1,2: 12.61 1,3: 37.45* 2,3: 24.84*	439.52 (15.24)	99.69	1,2: 16.17 1,3: 49.14* 2,3: 32.97*
	Medium	1 250	24.76	410.88 (5.34)	76.74		423.35 (7.01)	102.37	
	Low	3 393	65.4	386.04 (2.67)	75.2		390.38 (4.06)	102.44	
Parental involvement in school activities	High	216	3.95	450.00 (11.41)	71.21	1,2: 45.35* 1,3: 59.93* 2,3: 14.57*	472.08 (11.59)	84.75	1,2: 54.77* 1,3: 76.94* 2,3: 22.16*
	Medium	1 216	23.46	404.64 (5.44)	75.51		417.31 (7.31)	100.73	
	Low	3 757	72.59	390.07 (3.09)	76.9		395.14 (4.31)	103.7	
Students' regard for school property	High	418	7.23	413.25 (11.01)	78.62	1,2: 10.77 1,3: 24.09* 2,3: 13.32*	423.94 (14.62)	104.56	1,2: 13.15 1,3: 28.09 2,3: 14.94
	Medium	1 744	34.42	402.48 (5.00)	77.76		410.79 (6.45)	102.48	
	Low	2 942	58.35	389.16 (3.61)	76.31		395.85 (5.14)	103.84	
Students desire to do well in school	High	1 024	18.03	414.47 (6.22)	81.42	1,2: 14.70* 1,3: 34.11* 2,3: 19.41*	426.89 (8.61)	106.79	1,2: 18.31 1,3: 43.46* 2,3: 25.15*
	Medium	2 474	48.17	399.77 (3.35)	74.77		408.58 (4.65)	99.89	
	Low	1 691	33.81	380.36 (4.18)	75.96		383.43 (5.98)	103.78	

**Statistically significant at 5% level*

Teachers' job satisfaction, parental support, parental involvement, and students regard to school property are mostly categorised as either *medium* or *low*. For teachers' job satisfaction and the performance of the students for the *medium* and *low* options are almost similar. For parental support, parental involvement and students regard to property, the performance for the *low* category is the lowest for the group. Parental involvement and/or support should be encouraged in all the schools for students to do well. Students' desire to do well was highest for *medium* option and almost equal for *high* and *low* options. The performance of the students had a positive correlation with the views of the school heads in the three options. The other categories are classified mostly as *high* or *medium*. In all the characterisations, where the school head feels that it is *high*, the performance is also higher.

Negative School Climate and Students' Performance

The relationship between students' performance and negative attributes usually associated with students are presented in Table 6.15. School heads were asked to indicate to what degree the following attributes are prevalent in their schools. These are: arriving late at school;, absent from school with no apparent reason; class room disturbances; cheating; profanity; vandalism; theft; intimidation among students physical fights; and, intimidation of teachers.

Table 6.15: *Negative School Climate and Students' Performance*

Problem behaviour	Extent	n	%	Mathematics			Science		
				Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Arriving late at school	Not a problem	934	17.84	397.96(6.29)	75.24	1,2:0.60 1,3: 1.89	407.27(8.52)	102.64	1,2: 3.02 1,3: 1.59
	Minor problem	3 096	58.27	397.36(3.32)	76.86	1,4: 40.13*	404.24(4.75)	102.09	1,4: 53.33*
	Moderate problem	986	20.99	396.07(8.37)	79.65	2,3: 1.29 2,4: 39.53*	405.68(11.02)	107.01	2,3: -1.43 2,4: 50.31*
	Serious problem	138	2.9	357.84(5.02)	75.04	3,4: 38.23*	353.94(9.16)	102.24	3,4: 51.74*
Absenteeism	Not a problem	584	10.66	410.90(9.37)	76.89	1,2: 8.75 1,3: 26.45*	422.96(12.80)	106.13	1,2: 12.71 1,3: 32.63*
	Minor problem	2 738	52.56	402.15(3.89)	77.55	1,4: 32.82*	410.24(5.04)	101.59	1,4: 13.66*
	Moderate problem	1 290	25.43	384.46(4.08)	74.48	2,3: 17.70* 2,4: 24.07*	390.33(6.21)	102.64	2,3: 6.21* 2,4: 13.66
	Serious problem	577	11.35	378.09(9.65)	77.03	3,4: 6.37	382.44(13.66)	106.52	3,4: 13.66
Classroom disturbance	Not a problem	899	17.11	392.44(5.52)	74.5	1,2: -8.40 1,3: 6.94	396.67(7.44)	102.63	1,2:-13.34* 1,3: 8.66
	Minor problem	2 853	56.05	400.84(3.37)	78.4	1,4: -1.94	410.01(4.94)	103.21	1,4: -16.15
	Moderate problem	1 098	20.63	385.50(5.28)	76.16	2,3: 15.34* 2,4: 6.46	388.01(6.89)	104.19	2,3: 21.99* 2,4: -2.81
	Serious problem	266	6.21 2	394.38(15.10)	76.47	3,4: -8.88	412.81(20.56)	103.06	3,4: -24.80
Cheating	Not a problem	1 727	34	389.72(4.08)	77.93	1,2: -14.36* 1,3: 6.09	396.11(5.56)	106.13	1,2: -17.26* 1,3: 7.67
	Minor problem	2 604	51.42	404.07(3.65)	75.64	1,4: 8.05	413.37(5.39)	100.67	1,4: 7.07
	Moderate problem	629	12.57	383.62(6.61)	78.71	2,3: 20.46* 2,4: 22.43	388.45(8.21)	104.29	2,3: 24.93* 2,4: 24.33

	Serious problem	110	2.01	381.64(19.56)	80.29	3,4: 1.98	389.05(30.30)	111.14	3,4: -0.60
Profanity	Not a problem	1 034	23.16	400.47(7.30)	77.04	1,2: -0.19 1,3:20.33*	406.82(9.14)	101.05	1,2: -3.51 1,3: 24.13
	Minor problem	2 316	52.01	400.66(3.79)	77.66	1,4: 21.72	410.32(5.23)	103.47	1,4: 23.92
	Moderate problem	703	17.41	380.13(6.71)	77.04	2,3: 20.53* 2,4: 21.91*	382.69(9.84)	106.37	2,3: 27.63* 2,4: 27.43
	Serious problem	366	7.43	378.75(8.27)	78.28	3,4: 1.39	382.90(13.03)	106.69	3,4: -0.21
Vandalism	Not a problem	29	0.66	470.54(7.13)	59.45	1,2: 66.20* 1,3: 77.97*	504.79(5.72)	63.51	1,2: 92.51* 1,3:105.00*
	Minor problem	1 793	33.5	404.33(4.88)	78.22	1,4: 82.07*	412.29(6.17)	102.6	1,4: 109.50*
	Moderate problem	1 954	37.41	392.57(4.02)	76.79	2,3: 11.76 2,4: 15.86*	399.81(5.90)	102.74	2,3: 12.48 2,4: 17.04
	Serious problem	1 413	28.43	388.47(5.92)	75.71	3,4: 4.10	395.25(8.17)	104.95	3,4: 4.56
Theft	Not a problem	97	2.17	417.62(20.73)	74	1,2: 13.28 1,3: 19.62	428.87(34.62)	104.18	1,2: 15.08 1,3: 21.81
	Minor problem	1 968	37.91	404.34(4.69)	78.57	1,4: 43.14*	413.79 (5.36)	101.89	1,4:53.49
	Moderate problem	2 042	38.77	398.00(3.68)	74.44	2,3: 6.34 2,4: 29.86*	407.06(5.78)	101.14	2,3: 6.73 2,4: 38.41*
	Serious problem	1 082	21.15	374.48(5.33)	76.74	3,4: 23.53*	375.38(7.72)	106.23	3,4: 31.68*
Intimidation or verbal abuse among students	Not a problem	581	11.97	384.09(9.23)	81.23	1,2:-17.44 1,3:-10.84*	387.89(12.65)	109.3	1,2: -22.69 1,3: -15.14*
	Minor problem	2 483	46.71	401.53(4.24)	77.13	1,4:-2.33*	410.58(5.28)	101.57	1,4: -1.61*
	Moderate problem	1 601	31.25	394.92(4.21)	75.9	2,3:6.61* 2,4:15.12	403.03(6.29)	102.72	2,3: 7.55* 2,4: 21.08
	Serious problem	524	10.06	386.41(7.07)	75.82	3,4:8.51	389.50(11.34)	106.03	3,4: 13.53
Physical injury to other students	Not a problem	1 074	20.9	410.05(6.00)	78.54	1,2: 12.34 1,3: 27.16*	423.92(7.68)	103	1,2: 17.75 1,3: 39.63*
	Minor problem	2 734	52.21	397.71(3.43)	74.97	1,4: 38.92*	406.17(4.67)	100.36	1,4:55.72
	Moderate problem	1 210	23.08	382.89(5.93)	78.77	2,3: 14.81 2,4: 26.58	384.28(8.61)	106.22	2,3: 21.88* 2,4: 37.97
	Serious problem	171	3.81	371.13(13.29)	77.2	3,4; 11.77	368.20(20.99)	108.3	3,4: 16.08
Intimidation or verbal abuse of teachers or staff	Not a problem	2 347	45.93	399.18(3.93)	77.89	1,2: 0.03 1,3: 26.02*	407.58(5.22)	103.05	1,2: 0.34 1,3: 31.70*
	Minor problem	2 197	42.04	399.15(3.49)	76.38	1,4:9.25	407.24(5.20)	103.67	1,4: 21.25
	Moderate problem	545	10.71	373.15(8.31)	76.48	2,3: 26.00* 2,4: 12.06	375.88(11.85)	103.8	2,3: 31.36* 2,4: 20.91
	Serious problem	65	1.31	387.09(8.38)	64.25	3,4: -13.94	386.33(13.80)	91.25	3,4: -10.95
Physical injury to teachers or staff	Not a problem	4 281	82.69	399.37(2.95)	77.36	1,2: 17.33* 1,3: 28.56*	407.76(4.02)	103.4	1,2: 21.88* 1,3: 34.11
	Minor problem	708	13.92	382.04(5.63)	75.63	1,4: 12.62	385.88(8.98)	103.16	1,4: 19.76
	Moderate problem	86	1.93	370.81(13.34)	75.88	2,3: 11.23 2,4: -4.71	373.65(19.99)	101.96	2,3: 12.23 2,4: -2.12
	Serious problem	79	1.46	386.74(6.83)	73.8	3,4: -15.94	388.00(11.90)	103.68	3,4: -14.36

The responses from the school heads indicated that vandalism and theft are the only problem behaviours which have the largest percentage of students at categories of *moderate problem* and *serious problem*. The other problem behaviours are classified mainly under the categories of *moderate problem*, *minor problem* and *not a problem*.

Degree of Teachers' Problem Behaviours and Students' Performance

Late coming by the teachers to class and absenteeism from school are major problems facing school heads. The degree at which these two issues are problematic may have an adverse effect on performance as shown in Table 6.16.

Table 6.16: *Degree of Teachers' Problem Behaviours and Students' Performance*

Problem Behaviour	Extent of problem	n	%	Mathematics			Science		
				Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Arriving late or leaving early	Not a problem	314	6.12	431.19(17.07)	85.92	1,2: 35.40* 1,3: 42.02* 1,4: 33.88 2,3: 6.62 2,4: -1.52 3,4: -8.14	444.73(19.15)	108.55	1,2: 40.42* 1,3: 50.74* 1,4: 36.60 2,3: 10.32 2,4: -3.82 3,4: -14.14
	Minor problem	2 222	42.73	395.79(3.44)	75.58		404.31(5.21)	101.73	
	Moderate problem	2 133	42.32	389.17(3.82)	77.07		393.99(5.15)	103.97	
	Serious problem	403	8.83	397.31(11.26)	73.89		408.13(15.10)	100.33	
Absenteeism	Not a problem	674	12.64	412.69(9.98)	88.03	1,2:17.95 1,3: 22.30* 1,4: 25.58* 2,3: 4.35 2,4: 7.62 3,4: 3.28	423.66(11.56)	112.62	1,2: 21.39 1,3: 27.43* 1,4: 29.52 2,3:6.04 2,4: 8.13 3,4: 2.09
	Minor problem	2 688	53	394.74(3.12)	75.62		402.27(4.85)	102.33	
	Moderate problem	1 382	27.53	390.39(5.45)	75.29		396.23(6.95)	101.69	
	Serious problem	328	6.84	387.12(7.11)	72.93		394.14(9.27)	99.67	

**Statistically significant at 5% level*

Most of the students are from schools where the school head feels that arriving late or leaving early and absenteeism are a *minor problem* or a *moderate problem*. The performance of the students in both subjects is not affected much by the problem behaviours of the teachers.

Monitoring teachers performance

There are different ways which are used by various school heads and/or the Ministry to monitor the performance of the teachers. The common known methods are: observation by the principal or senior staff; observation by inspectors or other persons external to the school; student achievements; and, teachers peer review. Students' performance by teacher method of evaluation is presented in Table 6.17 and 6.18.

Table 6.17: *Students' Performance by Evaluation Method for Mathematics Teachers*

Evaluation Method	Endorsement	n	%	Mean(SE)	SD	Diff
Observation by the principal or senior staff	Yes	5 079	97.97	396.44 (2.54)	77.34	1,2: 28.62*
	No	110	2.03	367.81 (13.94)	74.89	
Observation by inspectors or other persons external to the school	Yes	3 222	63.44	397.10 (2.97)	76.23	1,2: 3.70
	No	1 932	36.56	393.39 (4.32)	79.47	
Student achievement	Yes	5 003	97.53	396.16 (2.63)	77.5	1,2: 14.27
	No	110	2.47	381.89 (13.36)	75.49	
Teacher peer review	Yes	3 175	61.01	402.38 (2.94)	76.37	1,2: 16.74*
	No	2 014	38.99	385.64 (4.28)	77.87	

**Statistically significant at 5% level*

Table 6.18: *Students' Performance by Evaluation Method for Science Teachers*

Evaluation Method	Endorsement	n	%	Mean(SE)	SD	Diff
Observation by the principal or senior staff	Yes	4 989	96.14	404.38 (3.70)	103.61	1,2: 25.11
	No	174	3.86	379.27 (16.07)	105.89	
Observation by inspectors or other persons external to the school	Yes	3 162	62.38	403.56 (4.12)	103.23	1,2: 0.71
	No	1 966	37.62	402.84 (6.06)	104.79	
Student achievement	Yes	4 977	96.24	404.04 (3.67)	103.87	1,2: 16.54
	No	186	3.76	387.50 (14.75)	101.1	
Teacher peer review	Yes	3 274	63.9	410.69 (4.39)	102.49	1,2: 19.78*
	No	1 851	36.1	390.90 (5.98)	104.74	

**Statistically significant at 5% level*

Observation by the senior management and student achievements are the two methods which are widely used to monitor the performance of teachers. Students performed better where teachers were observed by the principal or student achievement was used to monitor the teachers' performance. Teacher peer review seems to impact on the performance, but there is large number of students (38.99% in Mathematics and 36.10% in Science) who are coming from schools where teacher peer review is not used to evaluate the performance of the teachers.

Leadership Activities

School heads were asked to give an approximate time they spend on leadership activities. The activities were grouped together into an index which comprised of: promoting the school's educational vision or goals; developing the school's curricular and educational goals; monitoring teachers' implementation of the school's educational goals in their teaching; monitoring students' learning progress to ensure that the school's educational goals are reached; keeping an orderly atmosphere in the school; ensuring that there are clear rules for student behaviour; addressing disruptive student behaviour; creating a climate of trust among teachers; initiating a discussion to help teachers who have problems in the classroom; advising teachers who have questions or problems with their teaching visiting other schools or attending educational conferences for new ideas; initiating educational projects or improvements; and, participating in professional development activities specifically for school principals.

Table 6.19: *Time Spent in Leadership Activities and Students Performance*

Amount of time	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	mean (SE)	SD	Diff
Sometime	2 103	41.43	392.18 (3.52)	74.57		398.19 (5.17)	102.42	1,2: -6.94
A lot of time	2 944	58.57	399.12 (3.62)	79.62	1,2: -9.35	407.53 (4.85)	105.04	

**Statistically significant at 5% level*

Almost all students came from schools in which their head teachers were engaged in leadership activities at least sometimes. The mean performance is almost equal for *sometime* category and *a lot of time* category as presented in Table 6.19.

Summary

(1) Most of the students in the study were from schools which had enrolments ranging from 401 to 800. The performance of the students was not affected by the number of students enrolled in the school. The performance was also not affected by the enrolment of Form Two students.

(2) The majority of the students were from schools where the school head indicated that they were from an economically disadvantaged background and that their performance was lower than that of students from economically affluent homes.

(3) The majority of students in the sample were from villages followed by remote rural areas. The performance of the students varied with the locality of the school with students from urban areas performing better than students from other localities in the sample. The performance decreased with the change in the classification of the area. The performance is worse for students in remote rural areas.

(4) The results indicate that the performance of the students was not affected much by the availability of resources like computers, science lab and other resources needed to carry out instruction.

The majority of the students are from schools where school heads indicated that teacher job satisfaction was *medium* or *low* while teacher understanding of the curricular, teachers' degree of success in implementing curriculum and teachers' expectations for student achievement were *medium* or *high*. Parental support, parental involvement in school activities and students' regard for school property are *medium* and *low*. The performance of the students is *low* where parental support and students' regard for property is *low*. The main problem behaviours in Junior Secondary schools are vandalism and theft. Other problem behaviours are considered to be *minor*.

The majority of the students were from schools where evaluation of teachers' work was mainly through observation by the principal or senior staff and student achievement only. Teacher peer review and observation by inspectors was the method least used.

Recommendations

1 The disparities in the performance of students in urban areas and those in the rural areas should be addressed. There should be some educational reforms which are aimed at addressing the issue since a larger population of the students are in the rural areas.

2 Parental support and/or involvement in the learning of their children should be mandatory and not be optional as it is currently whereby many parents are not involved in the development of their children.

3 The resources in the Junior Secondary schools should be improved to cater for the needs of students in these schools. Computer laboratories and other specialised subject laboratories need to be upgraded to cater for needs of the subjects.

4 The curriculum should be building on what has been learned at primary school, with very little or no overlaps in the objectives. The Form Two curriculum can be reduced in size to focus more on the quality and depth of the subject content.

CHAPTER SEVEN

PARENT BACKGROUND VARIABLES AND STUDENTS' PERFORMANCE

Introduction

Parents/guardians of Form Two students who participated in the TIMSS study were asked to complete a questionnaire seeking background information that may help explain the pattern of performance of the students. The questions ranged from demographic information to socio-economic status/home environment, to involvement in school work, and valuing education. Each of these areas *is* discussed in detail in the sections that follow.

Demographic Variables

Demographic variables included: guardian relationship to the child' marital status; age; number of school-going children in the house; number of people living in the house; language spoken at home; educational level of father, mother, and children.

(a) Guardian demographic information

The student questionnaire was completed by the father, mother, guardian or non-related guardian. Mothers constituted the highest proportion (62.3%) of the guardians who completed the questionnaire and the least was the non-relative guardian (1.0%) as shown in Table 7.1.

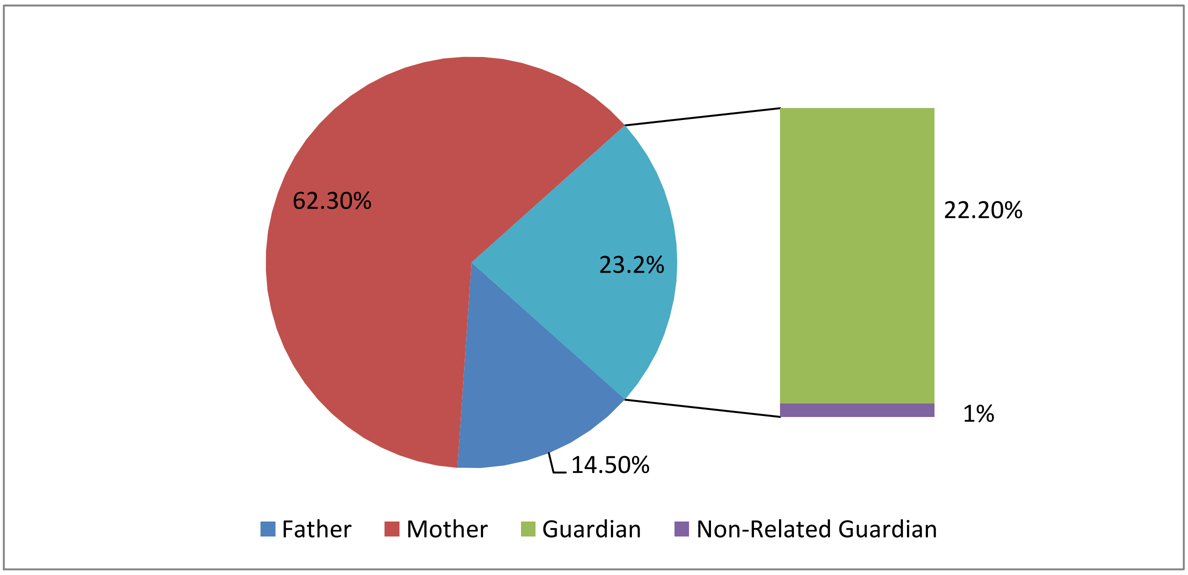


Figure 7.1: Relative Proportion of Guardians Who Completed the Questionnaires

Table 7.1: *Relative Proportion of Guardians Who Completed the Questionnaires*

Relative	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean (SE)	SD	Diff
Father	573	14.52	409.28(5.74)	82.50	1,2:7.90	421.79(7.14)	108.01	1,2: 11.29
Mother	2 432	62.25	401.38(2.67)	74.91	1,3:10.68	410.50(3.65)	100.27	1,3:11.95
Guardian	849	22.21	398.60(3.64)	74.45	2,3:2.78	409.84(6.25)	100.72	2,3:.0.66
Non-relative guardian	41	1.02	376.40(13.02)	79.66		367.07(19.20)	106.25	

**statistical significance at 5% level*

There were no significant differences in the performance of children staying with either relative. In Botswana, Junior Secondary schools are spread all over the country. Nevertheless, there are some small villages and settlements which do not have schools. As such, children from such villages who attend school in another village seek rented accommodation.

There was a biased interest towards mothers since they constituted the majority of the guardians, hence cross-tabulation of the *guardian relationship* variable with the *marital status* variable revealed that mothers constituted the majority of: single parents (66.4%); married parents (56.8%); co-habiting parents (66.0%); divorced parents (68.0%); separated parents (65.0%); and widowed parents (57.8%) as shown in figure 7.2.

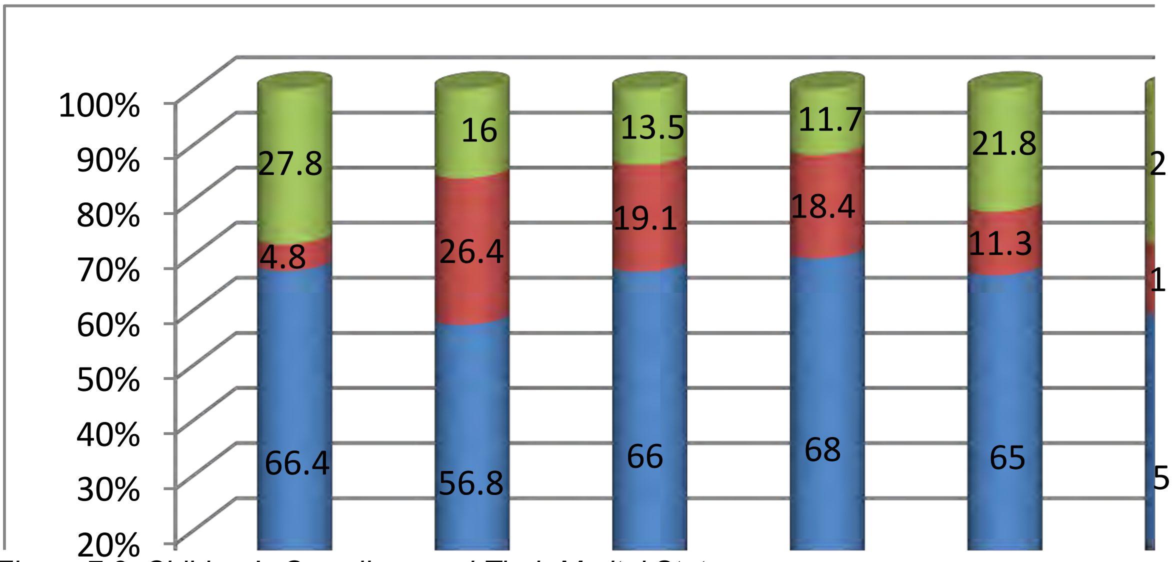


Figure 7.2: Children's Guardians and Their Marital Status

(b) Guardians Age

Parents who completed the questionnaire ranged from under 20 years to over 50 years, but the majority of the guardians who completed the questionnaire were 30 years and above, and the least were those under 20 years constituting 2.3% as seen in Table 7.2.

Table 7.2: *Guardians' Age*

Age category	n	%
Under 20	96	2.3
20 to 29	256	6.6
30 to 39	1 348	34.5
40 t0 49	1 406	35.7
50 or older	819	20.9

(c) Family size

To some extent, the size of the family matters. Table 7.3 below shows the size of families that the student lived with. Given that a modern nucleus family consists of husband, mother and two children, more than four people living in the same home were considered to be 'many'. Parents indicated that children stayed with families ranging from 2 people to 10 people. However, the majority of the families (73.7%) were large families with five or more people living together, representing an extended true African family. Children whose parents indicated that they stayed with fewer people in the family performed significantly better than those whose parents indicated that they stayed with more people in the family, in both Mathematics and Science as indicated in the Table 7.3.

Table 7.3: *Family Size*

Family size	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
4 or less	1 028	26.3	416.17(4.01)	76.12	1,2:20.61*	432.26(5.42)	98.74	1,2:29.30*
At least 5	2 917	73.7	395.5(2.78)	75.65		402.96(4.18)	102.13	

**statistical significance at 5% level*

(d) Language spoken at home

The majority of parents (78.4%) indicated that they spoke English *at least sometimes*. Children whose parents spoke English at home *at least sometimes* performed significantly better in both Mathematics and Science, than those whose parents indicated that they *never* spoke English at all at home, as shown in Table 7.4.

Table 7.4: *Frequency of Speaking English and Students' Performance*

Frequency of speaking English	n	%	Mathematics			Science		
			Mean(se)	SD	Diff	Mean(SE)	SD	Diff
At least sometimes	2 637	78.4	410.36(3.19)	74.63	1,2:25.59*	424.14(4.48)	98.52	1,2:38.92*
Not at all	732	21.6	384.41(3.41)	76.46		385.22(4.96)	104.80	

**statistical significance at 5% level*

(e) Parent's highest educational level

Parental education is also important in the child's learning. Traditionally, the boy-child was advantaged over the girl-child in terms of school attendance. However, analysis shows that mothers generally seemed to have attended school better than fathers as shown in Tables 7.5 and 7.6 below. For example, 20.7% of the fathers had never attended school at all compared to 11.4% of the mothers, while at least 54.64% of the mothers had completed at least secondary education compared to 50.8% of the fathers. Children whose parents indicated that they have higher educational qualifications performed significantly better than those whose parents indicated they have lower qualifications.

Table 7.5: *Fathers' Highest Educational Level*

Level of education	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Never attended school	723	20.7	378.48(4.08)	75.45	1,2: -1.88 1,3:-2.81*	377.24(5.81)	104.69	1,2:-2.13* 1,3: -2.98*
Did not complete primary education	358	10.3	388.92(3.76)	73.27	1,4:-4.19* 1,5:-8.23*	394.20(5.43)	101.66	1,4:-4.34* 1,5:-9.07*
Completed primary education	622	18.3	393.78(3.61)	73.23	2,3:-.93 2,4:-2.40*	399.23(4.56)	96.82	2,3:-.71 2,4:-2.27*
Completed secondary education	989	28.6	401.61(3.72)	73.39	2,5:-6.85* 3,4:-1.51	411.45(5.33)	98.72	2,5:-7.34* 3,4:-1.74
Completed post-secondary education	775	22.2	432.63(5.16)	74.05	3,5:-6.17* 4,5:-4.88*	456.55(6.54)	90.74	3,5:-7.19* 4,5:-5.35*

**statistical significance at 5% level*

Table 7.6: Mothers' Highest Level of Education

Level of education	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Never attended school	437	11.4	368.40(6.00)	76.79	1,2: -2.65* 1,3:-2.26*	366.11(8.54)	106.42	1,2: -2.32* 1,3:-1.98
Did not complete primary education	384	10.2	387.86(4.23)	72.00	1,4:-5.78* 1,5:-9.37*	389.27(5.15)	99.70	1,4:-5.72* 1,5:-9.63*
Completed primary education	893	23.8	383.54(2.97)	73.17	2,3:0.84 2,4:-3.71*	385.63(4.95)	101.15	2,3:0.51 2,4:-4.74*
Completed secondary education	1 326	35.7	406.66(2.80)	70.56	2,5:-8.19* 3,4:-5.66*	419.45(3.74)	93.74	2,5:-9.70* 3,4:-5.45*
Completed post-secondary education	708	18.9	443.38(5.30)	74.93	3,5:-9.85* 4,5:-6.13*	468.56(6.35)	89.84	3,5:-10.30* 4,5:-6.66*

**statistical significance at 5% level*

Socio-Economic Status/Home Environment

The socio-economic status of the family is normally associated with the students' performance, because it determines the ability of the family to provide for the child's educational needs. The following socio-economic factors were analysed: type of house; number of people working in a family; house amenities and goods such as refrigerator, running tap-water, electricity, telephone, flushing toilet, radio, television, video, and computer; family possessions such as motor vehicle, motor bike, bicycle, land, and livestock; source of income; and, expenditure on education.

(a) Type of house

Children either lived in huts or semi-permanent structures or permanent structures. The majority (81.6%) of the children lived in permanent structures. However, there were no significant differences in performance between children whose parents said they lived in permanent structures and those whose parents said they lived in semi-permanent structures.

Table 7.7: *Type of House the Child Lives In*

House type	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Semi-permanent	744	18.39	362.42(3.98)	73.26	1,2:-48.25	351.17(5.36)	98.60	1,2:-74.26
Permanent	3 130	81.61	410.67(2.72)	73.94		425.43(3.75)	97.47	

**statistical significance at 5% level*

(b) Levels of Household amenities and goods

Household amenities and goods constituted the following: refrigerator, running tap-water, electricity, telephone, flushing toilet, radio, television, video, and computer. Indices categorised into three levels, namely, *high*, *medium* and *low* were created for household amenities and goods. A *high* level of amenities indicated an average score of 1.00≤ X ≤1.34; a *medium* level of amenities indicated an average score of 1.35≤ X ≥1.64; while a *low* level of amenities indicated an average score of 1.65≤ X ≥2.00. Based on this categorisation, it was found that, a large proportion of families (43.2%) possessed high levels of household amenities and goods as indicated in Table 7.8. Children whose parents indicated that they had more amenities and goods performed significantly better than those whose parents indicated that they had fewer amenities.

Table 7.8: *Levels of Household Amenities and Goods*

Amount of amenities	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
High	1 687	43.2	424.58(3.75)	74.47	1,2:33.05*	445.11(5.05)	96.19	1,2:46.80*
Medium	784	20.0	391.53(3.17)	74.56	1,3:45.78*	398.31(4.44)	101.54	1,3:67.51*
Low	1 465	36.9	378.80(2.90)	71.31	2,3:12.73*	377.60(4.03)	96.10	2,3:20.71 *

**statistical significance at 5% level*

(c) Levels of Family possessions

Family possessions represented capital assets such as motor vehicle, motor bike, bicycle, land, livestock and source of income. Families' sources of income varied from salary, livestock, to Government support as indicated in Table 7.9. The majority of families (54.2%) indicated that they derived their source of income from salaries, compared to other sources of income. The least main source of income was Government support with 14.6% of the families depending on government hand-outs.

Table 7.9: *Families' Source of Income*

Source of income	Assenting	n	%
Salary	Yes	1 953	54.2
	No	1 685	45.8
Livestock	Yes	899	26.0
	No	2 513	74.0
Farm Produce	Yes	509	15.3
	No	2 831	84.7
Business	Yes	930	26.8
	No	2 521	73.2
Govt. Support	Yes	491	14.6
	No	2 849	85.4

Indices categorised into three levels, namely, *high*, *medium* and *low* were created for family possessions. A *high* level of possessions indicated an average score of 1.00≤ X ≤1.34; a *medium* level of possessions indicated an average score of 1.35≤ X ≥1.64, while a *low* level of possessions indicated an average score of 1.65≤ X ≥2.00. Based on this categorisation, it was found that, a large proportion of families had *medium* levels of possessions (45.2%) as indicated in Table 7.10. Children whose families indicated that they had low levels of possessions performed significantly lower than those whose parents indicated that they had *high* or *medium* levels of possessions.

Table 7.10: *Levels of Family Possessions*

Amount of possession	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
High	525	13.1	398.69(5.76)	81.03	1,2:-9.06	411.41(7.32)	105.90	1,2:-6.54
Medium	1 763	45.2	407.75(3.64)	76.63	1,3:3.72	417.95(4.89)	102.30	1,3:8.16
Low	1 631	41.7	394.97(2.61)	73.65	2,3:12.78*	403.25(4.14)	99.87	2,3:14.70*

**statistical significance at 5% level*

(d) Expenditure

Education in Botswana is almost free for public schools. Parents contribute only 5% of the total cost and those who cannot afford it, are catered for by the Social Work department. Nevertheless, parents should play a significant role in assisting their children learn at home for improved performance.

An index was created for parental expenditure on their children's educational needs, as either *high* or *low* expenditure. It was found that the majority of parents (74.8%) spent more on their children's educational needs. And those spending more, their children performed significantly better, in both Mathematics and Science, than those who spent less. However, a smaller proportion of parents (15.2%) reported that their children sometimes stayed home due to lack of money to support their educational needs in terms of school fees, transportation, books, school uniform or any other need.

Table 7.11: *Families' Expenditure and students' performance*

Level of expenditure	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
High	2 926	74.8	405.93(3.08)	76.26	1,2:18.47*	417.83(4.20)	101.07	1,2: -0.68 *
Low	994	25.3	387.16(3.30)	74.33		390.64(4.76)	101.75	

**statistical significance at 5% level*

Parental Involvement in School Work

Parental involvement in children's school work is vital for their success. Most of the learning takes place at home informally and it is only formalised in schools. The amount of help that the child receives is related to both the level of understanding of educational importance and the educational level of the parents. Table 7.12 below shows that children received help *regularly* and *sometimes* from the parents they stay with (i.e. the person who completed the questionnaire), while those who helped them least were spouses of those who completed the questionnaire. Probably those spouses live and work in a different location from their families
.

Table 7.12: *Source of Help for the Child*

Source of help	Frequency of assistance (%)		
	Regularly	Sometimes	Not at all
Myself	36.2	50.6	13.2
Spouse	6.7	32.9	60.3
Child's sister	23.0	41.6	35.4
Child's brother	18.6	39.7	41.7
Family member	15.7	56.0	28.3
Neighbour/friend	20.1	52.6	27.4

Table 7.13 shows that just about 19% of the parents participated *regularly* while the majority (72.0%) participated *sometimes* in their children's education through school activities - such as discussing the progress of the children with the teacher or discussing school work with the child. Children whose parents indicated that they helped with school work at home *regularly* performed significantly better (M = 409.66, SD = 5.05) than both those whose parents helped *sometimes* (M = 400.02, SD = 2.87) and those not helped at all (M = 391.77, SD = 4.52), in Mathematics only, while there was no significant differences between the frequency of participation in Science.

Table 7.13: *Frequency of Participation by the Parents in Child's School Work*

Frequency of participation	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Regularly	753	19.1	409.66(5.09)	79.61	1,2: 9.64	418.80(6.51)	105.94	1,2:8.98
Sometimes	2 815	72.0	400.02(2.87)	75.31	1,3:17.89*	409.82(4.06)	100.76	1,3:16.00
Not at all	352	8.9	391.77(4.52)	74.23	2,3:17.89*	402.80(7.23)	101.73	2,3:7.02

**statistical significance at 5% level*

The high participation by parents in their children's education was not surprising as the majority of parents (91.5%) highly valued education as shown in Table 7.14. However, children whose parents valued education performed significantly higher than those whose parents did not.

Table 7.14: *Parental Valuing of Education*

Valuing Education	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Yes	3 569	91.52	405.17(2.78)	75.09	1,2:42.13*	416.27(3.97)	100.15	1,2:57.45*
No	328	8.48	362.04(5.32)	76.12		358.82(7.11)	104.75	

**statistical significance at 5% level*

Parents reported that children were also involved in helping at home to do the home chores as an extension to learning. Although home chores are important in the normal upbringing of the children, it should not take much of the children's time of doing school work. The majority of parents (65.3%) reported engaging children in doing home chores *sometimes* compared to 12.8% who engaged them *regularly* after school. However, there were no significant differences in performance between children who were involved in home chores at different frequencies as seen in Table 7.15.

Table 7.15: *Children's Frequency of Involvement in Home Chores*

Frequency	n	%	Mathematics			Science		
			Mean(SE)	SD	Diff	Mean(SE)	SD	Diff
Regularly	503	12.8	380.67(4.06)	73.09	1,2:-19.01 *	383.26(5.88)	100.92	1,2:-25.77 *
Sometimes	2 537	65.3	399.68(3.00)	76.44	1,3:-37.13 *	409.03(4.44)	102.46	1,3:-50.39 *
Not at all	862	21.9	417.80(3.78)	73.55	2,3:-18.12 *	433.65(4.84)	95.31	2,3:-24.62 *

**statistical significance at 5% level*

Summary

Majority of children's questionnaires were completed by:

(i) their mothers, and it can be inferred that majority of children stay with their mothers at home who were mostly single.

(ii) Parents whose age ranged from under 20 years to over 50 years, dominated by those 30 years and above. It is interesting to note that there were some parents who were under 20 years constituting 2.3%

(iii) mothers who generally had attended school better than fathers and such children were performing better than those whose parents indicated they have lower qualifications.

The family size that the students stayed with ranged from 2 to 10 people, and children stayed with large families constituting five or more people. Such children performed lower than those who stayed with small families. Majority of parents spoke English at least part of the time Speaking English at home with children seemed to be associated with students' performance

The socio-economic status of the family was found to be associated with students' performance because such parents were able to provide for their children's educational needs. The socio-economic factors considered were: type of house; number of people working in a family; house amenities and goods such as refrigerator, running tap-water, electricity, telephone, flushing toilet, radio, television, video, and computer; motor vehicle, motor bike, bicycle, land, and livestock; source of income; and expenditure on education.

Parents were more often engaged in their children's school work through school activities, discussing the progress of the child with the teacher, or discussing school work with the child and such engagement was positively related to students' performance. The high participation by parents in their children's education was not surprising as majority of parents (91.5%) highly valued education.

Parents reported that children were also involved in helping at home to do the home chores as an extension to learning. Although home chores are important in the normal upbringing of the children, it should not take much of the children's time of doing school work. Majority of parents (65.3%) reported engaging children in doing home chores 'sometimes' compared to 12.8% which engaged them regularly after school. However, there were no significant differences in performance between children who were involved in home chores at different frequencies as seen in Table 15.

Recommendations

It is recommended that:

1. guardians should try by all means to speak to their children in English at home as early as possible, to facilitate their children's mastering of the language as it is used as a medium if instruction at school as early as Standard Two.

2. The government in partnership with the business community set up resource centres equipped with modern gadgets and equipment that children can use after school as another way of learning

3. The Ministry must come up with a strategy that will facilitate and enable parents to be actively involved in their children's education both at school and at home.

CHAPTER EIGHT

SUMMARY

Introduction

Botswana participated in TIMSS study to improve the quality of its education by: assessing the level of mathematics and science learning of students; identifying factors that impact on teaching and learning; and by comparing achievement and teaching and learning conditions among the participating countries. Assessment was based on a common international framework which mirrored at least 90% of the country's curricular. The information obtained was used to inform curricula reviews and for planning and implementing educational initiatives. Information generated through TIMSS is intended to be used by educators to plan and execute activities that lead to improved learning of Mathematics and Science.

Botswana's target population for the 2011 study was Standard Six (Grade 6) students. These were students who had six years of schooling. Botswana, Yemen and Honduras used Standard Six students while the rest of the countries used Grade Four students. This was because of the pilot results which showed low scores by our Standard Four students thus introduced a lot of measurement error in the international and national results.

TIMSS procedures were highly standardised to enable comparison between countries. As such, a lot of materials on the conduct of the study were sent by the study centre to individual countries. These included *Survey Operations Procedures* and Manuals. Some of the activities such as *Sampling* were done by the study centre itself to ensure similar outcomes. Twenty-five schools were sampled for pilot while 150 schools were sampled for Main Survey for Botswana using multi-stage stratified cluster with the probability of being sampled proportional to the school size (PPS) technique. Two classes were randomly selected in each school sampled for the pilot, while only one class was selected at random for the main survey.

Students' performance was reported based on four points on the scale used as benchmarks. The four benchmarks were low, intermediate, high and advanced. Items were of the select-format as well as problem-solving in an open-ended format which offered better insight into the analytical, problem-solving and inquiry skills students. More investigative and production-based tasks were set in order to be able to cater for the cognitive domains that had been identified. After compiling the test booklets, cultural adaptation of the items which involved checking the items for any cultural aspect in the item that would make it unsuitable for the intended population was conducted. The process of cultural adaptation included translation from English to the language of instruction in countries that did not use English for instruction.

Background questionnaires were also developed and administered to School Heads, Mathematics and Science teachers, parents and students. The questionnaires were similarly subjected to cultural adaptation and translation as were the achievement instruments. Questionnaires were constructed according to themes. The items were grouped together to form one or more construct. The name of the construct was representative of the underlying construct. Indices were formed by calculating the mean response for that construct. Negatively worded items were reversed before analysis was done to align the item with the rest. A scale average was set at 500 (as mean) and a standard deviation at 100. SPSS sitting on the International database Analyser (IDB Analyser) platform was used for analysing the data. Data analysis was mainly by means, standard deviation, and regression.

Students' performance

Botswana used grade 9 students instead of grade 8 as was the case in the previous cycles. Despite that, they performed unsatisfactory in both subjects and the performance was lower than the international benchmark mean of 500. The overall mean achievement for mathematics was 397 while for science it was 404. Despite Botswana's participation at a higher grade (higher age), it was ranked third from the bottom in both Mathematics and Science out of 45 countries. The best performing country in mathematics had an average score of 613 while the best performing country had an average score of 590 in science. Performance at each international benchmarks shows that 50% and 45% of our students failed to reach even the lowest benchmark in mathematics and science respectively, while for the top performing countries, at least 90% of their students reached the lowest benchmark. Thus our Form Two students could not handle materials that could be handled with ease by students of lower grades (lower age) from other countries.

Despite low achievement, performance by mathematics content domains showed that students performed best in Algebra (406.81) and the least in Geometry (380.68). On the other hand, the performance in the Science content domains was best in Physics (417.03) with the least performance in Earth Science (384.39). Cognitively, students performed best in Knowledge compared to the other domains. Although there was no statistically significant difference between boys and girls performances in both Mathematics and Science, girls performed better than boys in almost all the content domains in both mathematics and science. In Mathematics cognitive domains, the best performance was in *Knowing* for both boys and girls, and the difference between the means was statistically significant at 5% level. In Science, girls performed best in *Reasoning* with a mean of 410.65, while the boys' best performance with a mean of 401.15 was in *Applying*. In science, girls performed much better than boys in all cognitive domains and all the content domains.

However, it should be noted that by the time students wrote the TIMSS tests, students had not yet covered enough in some topics. For example, about 16% of the students had not yet covered *Data and Chance* topic in mathematics, while 81% and 74% of students had not yet covered *Chemistry* and *Earth Science* topics respectively in science. The low performance by students could then partly be explained by lack of content coverage and in-servicing of some problematic topics for teachers. Thus our students could have done relatively well in mathematics and possibly above mean average in science had they covered enough content.

Students' performance was found to be positively associated with their background variables such as number of books in the family, home possessions, home support, bullying at school, students' safety at school, parental involvement in students' work, students' perception about school, and students' attitudes, among others. That is, performance of students who came from homes with desirable background factors was higher than those who came from less favourable home background factors. It is therefore paramount for the education system to improve family socio-economic status which will in turn improve students' performance for better comparison with the international students.

Teacher background variables

The importance of the teacher in students learning cannot be overemphasized. The characteristics or quality of teachers in terms of individual characteristics and professional competency go a long way in ensuring that quality education is provided to students. Generally most students were taught by teachers who had at least degree qualification in education. Despite that, students who were taught by teachers with diploma qualification performed better than those taught by degree holders. Nevertheless, this could be attributed to the interaction of age, experience and qualification as most diploma holders were of older generation with more experience of classroom management and content delivery. Older and more experienced teachers were not only acting as classroom teachers but as parents as well whom students could trust and rely on to handle their social needs.

Teacher's professional attitudes, behaviours, expectations and practices were important features in the delivery of instruction and imparting knowledge to the students. Students who were taught by teachers who had positive outlook in their professional work were performing better. Thus it can be said such teachers were more efficient and effective in teaching, translating to higher performance of the students. Generally, teachers were demotivated by the work conditions prevailing in schools which affected instruction and their ability to motivate students and apply various pedagogical strategies to facilitate students learning, despite their suggestions that they were confident in performing their professional tasks.

Schools are to some extent, still a safer environment for teachers, although there is a growing trend of disorderly and disrespectful behaviour by some students. This development requires proactive intervention to review and put in place security policies and procedures that will ensure that everybody is safe in the school to facilitate teaching and learning. Schools are physically in a bad state for learning. buildings were dilapidated requiring significant repairs; classrooms were overcrowded; teachers had too many teaching hours; teachers did not have adequate workspace for preparation, collaboration, or meeting with students; there was acute shortage of instructional materials and supplies; and there were few available computers in schools and associated assistance to teachers.

Computer assisted instruction has gained popularity in advance countries and is widely adopted by majority of developing countries. The status of few to none computers in schools is indeed retrogressive to learning. A handful (about 13%) of schools had computers and about 90% of the available computers were connected to the internet, yet students did not use them for gainful learning. Whenever students have enough resources and given support either at home or at school they tended to perform better. Due to this objectionable status of resources shortage in schools, teachers used the little available for supplementary purposes and heavily relied on improvisation for basic instruction. This grossly affected students' performance since whenever the little resources were used, students tended to comprehend the materials better as evidenced by their higher achievement.

Teaching and assessment are intertwined. Teachers should undertake formative evaluation of their instruction using various methods, on regular basis. This gives them valuable information on the students learning for better planning the next lesson. As much as teachers should be well trained in pedagogical instruction, they should also be well trained in evaluating students learning. Teachers placed emphasis on evaluating on-going work using classroom tests frequently. They also endorsed the use of national and regional achievement tests. However, frequent use of classroom tests did not yield desirable results possibly because teachers training didn't emphasise assessment as an integral component of teacher preparation.

Teachers' classroom tests were dominated by recall kind of questions followed by questions of the application domain with little emphasis on abstract reasoning questions which are critical in revealing comprehension of the materials beyond mastery. Although teachers teach and assess the way they assess, they don't get much help from in-service department. For example, although teachers indicated that they had problems in advance for lessons, they had problems preparing for *Earth Science* topic in science. In-service courses to equip teachers with modern teaching and assessment skills were very rare, yet it has proven that students taught with teachers who attend in-service regularly performed better. This indeed attests that in-service courses are vital for the effectiveness of the teacher, because they do not only serve to impart teachers with skills, but also as motivational.

General lack of resources, lack of participation in professional development, lack of confidence and preparedness to teach certain content domains hampered teacher efficiency and effectiveness, consequently affecting students' performance. As such, these issues needed to be addressed for the betterment of the overall performance of students. Teachers' interaction with the parents was limited, as the schools consultation with parents about issues concerning students and schools was not satisfactorily. It is once in a while that parents are informed about what is happening in the school. Despite this lack of interaction, there are instances where teachers do not send reports at all about students' progress to the parents, further limiting the possibility of knowing what the other side is doing.

School background variables

Schools enrolment in Botswana range from around 200 to more than 1200 students, although majority fall in the range of 401 - 800. Contrary to abundance of literature, medium to large schools tended to perform better probably due to economies of scale as the Ministry releases funds per student. Thus large schools get more money to purchase resources and materials which are shared by the students for optimal benefit. Majority of schools had more students who came from poor families and students from such schools performed lower than students from schools which had more students coming from better off families. Although the language of instruction is English from Standard Two so that the students get used to the language of the test, majority of students spoke other languages other than English.

School heads concurred with the view of the teachers that resources were grossly inadequate in schools. However, students' performance was not affected much by the availability of resources like computers, science lab and other resources needed for instructional purposes. It looks like there are other factors such as large class sizes, lack of skills by teachers to use such resources, poor pedagogical skills, congested curriculum that interfere with the usage of available resources. However, some schools had some computers but students did not have access to their usage during class as observed by teachers. Those who had access to them seemed not to use them for educational purposes or did not know how to use them for educational purposes since their scores were not in any way different from those who had no access.

According to the school heads, majority of students were taught by teachers who had moderate to high job satisfaction; teachers with understanding of the curricula; and teachers with high degree of success in implementing curriculum. There was lack of teachers' holistic evaluation of their performance. They were mostly evaluated through observation by management team member and through students' achievement. There was no collaboration as teachers never carried peer review and schools inspectors hardly observed them.

Schools are permeated with undesirable problem behaviours such as absenteeism, vandalism, theft, intimidation or verbal abuse, among others which are not conducive for learning. Likewise, teachers too showed problem behaviours which could also affect students' performance, such as late coming or leaving early, and absenteeism. These could be precursors for teacher demotivation or dissatisfaction of their working conditions.

Parent background variables

According to guardians, learners engaged in non-formal pre-school activities like numeracy and literacy, as evidenced by children's high literacy rate (92.0%) and some arithmetic competence when they started school. It was found that non-formal pre-school activities were positively associated with performance. Pre-schooling attendance is not compulsory in Botswana, as such only slightly less than half (46.43%) of the children had attended pre-schooling, and such children scored higher marks, However, parents who did not have the means to send their children to pre-primary formal set-up, continued with informal teaching of their children at home. About 9% of the students started schooling at the right age of five years or younger. At least 94% of Botswana children started school when they were 7 years or younger, as per the policy requirement and they performed better than those who started at a later age. However, either early schooling or the number of years spent in pre-school was also of paramount importance in the child learning and performance.

Students stayed with guardians of varying ages ranging from as young as 20 years to over 50 years. Mothers constituted the highest proportion (62.3%) of the guardians who completed the questionnaire and the least was the non-relative guardian. Majority of guardians staying with the students were single parents. However, children staying with either relative just performed the same.

Form two students did not only stay with the guardian, but with other family members such as brothers, sisters, cousins and so on. The family size ranged from 2 people to 10 people, but most of the family sizes had 5 or more members. Children staying in small families tended to perform better possibly because more money was spent on the children's educational needs than spending on the needs of other members in a large family. Although children were encouraged to speak English even at home, majority spoke their mother tongue languages. Those who spoke English at home tended to perform better possibly because they understood the language of the items better. Generally more mothers attended school than fathers. For example, 20.7% of the fathers had never attended school at all compared to 11.4% of the mothers, while at least 54.64% of the mothers had completed at least secondary education compared to 50.8% of the fathers.

Overall, students' parents were of middle income status as indicated by the level of socio-economic status. Families of medium to high level of socio economic status posed amenities and gadgets necessary for their children's learning. They also spent more money on their children's education. Children from well-to-do families with all the supporting facilities coupled with environment conducive for learning achieved high scores. It is worrisome that there are still some children who stay away from school due to lack of money to support their educational needs in terms of school fees, transportation, books, school uniform or any other need.

The amount and quality of help that the child receives is related to both the level of understanding of educational importance and the educational level of the parents. Children received help *regularly* and *sometimes* from the parents they stayed with. Parents and teachers collaboration was not satisfactory. Parents' participation in their children's education was optional. They chose when to participate and when not to even when called to discuss the child's progress or school work with the teacher. Yet participation in ones child's education was positively associated with performance, because children learnt something from either party or sometimes the parent would explain better than the teacher. Despite poor participation in their children's education, parents highly valued education.

Children do not only learn at school, there is a lot of learning taking place at home. As such, parents involved their children in helping at home to do the home chores as an extension to learning. Although home chores were important in the normal upbringing of the children, it should not take much of the children's time of doing school work. *Generally, children who were exposed to favourable learning environment such as better socio economic status, fewer family members, getting assisted with school work at home, high valuing of education by parents, and high educational level of parents, tended to score higher in the tests.*

CHAPTER NINE

RECOMMENDATIONS

There are numerous varied recommendations that are made based on the findings of the study. Some of the recommendations are similar to the ones made in the previous TIMSS study reports but they have not been implemented up to date.

1. Pre-Primary education should be formalised

Pre-primary education should be formalised just like any level of education in Botswana. It should be made free and compulsory to all children under the age of five. The initial cost of a project of such magnitude will be huge, but in the long run, the benefits will outweigh the capital investment. Children who attend pre-primary schools get accustomed to learning early, and make learning part of their culture. Since children who attended formal set-up of pre-primary education and those who were taught informally at homes performed better than those who did not have formal pre-primary or informal one.

Internationally, the ISCED considers pre-primary to be an integral part of the education structure, hence when TIMSS was conceived, it was to be administered to students who have ten years of exposure to education (eighth graders or Form Two). Students starting early will learn English at pre-primary and by the time they reach Standard 2, where English is used as a medium of instruction, thy will not have any problem understating the lessons and consequently comprehending the items which contain more reading.

2. Establishment of a fully-fledged Support Service Department in schools

Although repetition is meant to give children a chance to prove themselves, it could also act against the intended objective because students made to repeat would be left behind their age mates and this may bother them and disturb learning. Repetition should be the last resort when effective remedial teaching has failed to yield desirable results. As such, a fully-fledged Support Service Department should be established with the aim to assist those students who need accommodation during instruction. Given that students develop and learn at different rates and are talented in different ways, teachers can not effectively unearth the different talents that students have with the current large class sizes and high pupil/teacher ratios. More support staff will be employed to assist teachers during the lessons, thus reducing the student/teachers ration to manageable levels. This will ensure that almost all, if not all, students attain the promotion to another level. The work of the teachers is more demanding nowadays due to ever-changing classroom dynamics. Classrooms are imbued with problem behaviours which need the skills beyond those of the teacher. The engagement of counsellors and Psychologist in our school system is thus of utmost importance to deal and investigate student problematic behaviour to determine the root cause.

3. Homework policy

Since learning takes place anywhere anytime, schools should therefore give reasonable amount of homework almost everyday. In fact some children learn better at home than at school. The ministry should come up with homework policy which will compel parents to help their children with homework as well as schools to monitor homework. The policy should spell out the responsibility of each party. The homework policy should be realistic and enforceable. The policy should be explained to the students and parents at the beginning of the school year. The policy will also facilitate/enhance the opportunity for teacher-parents interactions.

4. Safety at school

Learning can only take place in a safe environment, but our schools are no longer a safe place for leaning. The school environment is changing and the situation needs to be tackled while it is still at infancy stage. Teachers and students alike are not safe as such there is a need to develop policies and procedures that will ensure safe working environment for both. Teachers and parents need to work together in the moulding of the child, hence the need to revisit the ‘’Community Junior Schools” model of running the schools, where the community was actively involved. There is no doubt that a lot of changes have taken place since it was abrogated, as such they need to be factored in.

5. Organizing regular in-service courses

Teachers need to attend in-service courses regularly. Since curriculum is dynamic, new modern and advanced materials are always incorporated into the curriculum. Regular in-service course will not only serve imparting teachers with necessary skills to deliver the curriculum, but also motivate teachers to do their work. Thus the department of in-service training should be fully staffed to enable it to support teachers throughout the year and organise regular courses on problematic topics, throughout the year, identified through interaction with teachers. One such area will be the interpretation of the curriculum objectives.

6. Provision of adequate resources

Schools should be maintained in regular basis to make them conducive for learning. Adequate resources should be availed to schools to enable instruction to be planned and conducted using various strategies to enhance learning. The ministry through the relevant department in consultation with mathematics and science teacher panels come up with a policy on both infrastructure and human resources needed to enable the subjects to be taught more practically. The policy should not fall short of specifying, among others: standard list of physical resources needed, e.g instructional materials; teacher/student ratio; equipment for each topic; and development of instructional materials. Such materials should then be provided and schools accredited to meet set requirements of offering the subject. Schools should then apply on yearly basis for accreditation to offer the subjects. This will ensure that the available resources are not stretched beyond their capability, and can then be extended to all subjects if quality of education is to be achieved.

7. **Strengthening of pre-service teacher training programme**

The quality of the education system depends much on the quality of the teacher. There is need to upgrade teachers qualification from diploma level to degree level to improve their operational efficiency. Training institutions need to strengthen their partnership and work collaboratively with the industry, particularly in developing the programme content. They should adopt the interactive-iterative process of programme development. This will ensure that the product they produce is consumable by the industry they train for. Likewise, the programme should place emphasis on training students-teachers on assessment, so that teachers can set quality tests evaluating the students' holistic understanding of the subject matter. The teaching practice programme should also be strengthened by assigning student-teachers to older and more experienced teachers.

8. Involvement of parents in students learning

The ministry should come up with a policy on parental involvement in the education of their children. Parents should be equally involved in their children's learning. Such support will help in curbing problematic behaviours and encourage both students and teachers to take their studies seriously and teachers will feel supported and boost their morale.

REFERENCES

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