COMPARATIVE ANALYSIS OF THE PREDICTIVE VALIDITY OF BOTSWANA 2012 AND 2013 JCE RESULTS USING 2009 AND 2010 PSLE GRADES IN MATHEMATICS

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APPROVAL PAGE

This research project has been examined and approved as meeting requirement for the partial fulfilment of the Degree of Master of Education in Research and Evaluation

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Statement of Originality

This research project was completed by the author at the University of Botswana between January 2015 and June 2015. It is an original piece of work except where due reference has been made. This work has neither been nor will be submitted for an award at any other university.

Dedication

This work is dedicated and committed with all appreciation and thanks to my Lord and Saviour Jesus Christ, who through His grace enabled me to persevere through the pressure of work and may His Holy name be praised.

To my husband, Jeremiah Mookami Mareka whose love, dedication, support and encouragement helped me to stay focused on this study. To our children Tsholofelo, Bakang, Thapelo, Boipelo and our nephew Gladwin, who through their understanding, supported and encouraged me to keep on working hard to achieve my goal. It is also dedicated to my entire family, my aunts, uncles, sisters and friends for their support, love and encouragement throughout my entire programme.

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VALIDITY OF PSLE PREDICTING JCE MATHEMATICS

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Acronyms

BEC- Botswana Examination Council

BGCSE – Botswana General Certificate of Secondary Education

BIUST- Botswana International University of Science and Technology

CD & E- Curriculum Development and Evaluation

JC –Junior Certificate

JCE- Junior Certificate of Education

JCE- Junior Certificate Examinations

JSC- Junior Secondary Certificate

JSCE- Junior Secondary Certificate Examinations

KCPE-Kenya Certificate of Primary Education

KCSE- Kenya Certificate of Secondary Education

MoE- Ministry of Education

MoE&SD- Ministry of Education and Skills Development

NCE –National Commission on Education

OECD- Organisation for Economic Co-operation and Development

OSCE- Objective Structured Clinical Examination (OSCE)

PISA- Programme in International Student Assessment

PSLE- Primary School Leaving Examination

ROC- Receiver operating characteristic (ROC)

RNPE- Revised National Policy on Education

SMASSE – Strengthening of Mathematics and Science in Secondary Education

SPSS –Statistical Package for the Social Sciences

SSC – Senior Secondary Certificate

SSS- Senior Secondary School

WASSCE - Western Africa Senior School Certificate Examination

Comparative Analysis of the Predictive Validity of Botswana 2012 and 2013 JCE Results Using 2009 and 2010 PSLE Grades in Mathematics

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Abstract

A significant number of students obtain better grades in mathematics in PSLE, but fail to maintain or obtain higher grades in JCE mathematics examinations. Given that content in the mathematics syllabus is arranged in a spiral format from primary level through junior secondary level, the anticipation is that the students who did well in mathematics at primary school would maintain or improve their grades at JCE level. This study investigated the validity of PSLE mathematics grades in predicting performance in JCE mathematics. The study adopted inferential survey using simple random sampling technique carried out through online random number generator. The study population is comprised of 74490 students from 207 J. S. S. in Botswana who sat for JCE mathematics examinations in 2012 and 2013. Out of this population, 50 schools were randomly selected for matching PSLE 2009 mathematics scores and JCE 2012 mathematics scores. Another 50 was randomly selected for matching PSLE 2010 mathematics scores and 2013 mathematics scores. These schools yielded a sample of 15 294 students. Data was collected from BEC and analyzed by finding regression coefficients. For all the hypotheses tested 50% or more of variance in JCE mathematics performance is explained by variance in PSLE grades. The prediction models for PSLE in the two years were determined by fitting the values of relevant parameters in the linear regression model. The finding revealed that PSLE mathematics scores were a good predictor of performance among junior secondary students in Botswana. The regression analysis also revealed that there is no significant gender and school location difference in validity of PSLE mathematics scores in predicting performance in JCE mathematics. Since performance level was generally low in both examinations, it is recommended that the MoE & SD intensify efforts in ensuring better teaching methods and learning strategies in schools through

effective supervision and monitoring of schools. Discussions, implications and recommendations based on the findings were also presented.

CHAPTER 1

The Problem

Introduction

Performance in mathematics in Botswana has persistently been very poor and this has been a major concern for the government and the society. Trends in mathematics and science study (TIMSS) revealed that competitiveness of Botswana learners' achievement levels in science and maths is poor as compared to their counterparts from around the world (Nkate, 2008). Performance in mathematics as reflected by the JCE and BGCSE results has remained poor over the years. Venson- Moitoi (2014) said at the official opening of Mathematics Association of Botswana annual conference that mathematics is the fundamental of learning in all aspects of life, adding that it is the foundation of all learning, reasoning, order and sequence. Nkate (2008) also emphasized that mathematics is seen as the foundation of science and technology that are major economic drivers in today's knowledge society that wants to be competitive in global economy. In spite of the important role that mathematics plays in society, there has always been poor performance in the subject at national examinations.

Currently, students tend to obtain better grades in PSLE than in JCE. Out of all the students who set for 2014 PSLE mathematics examinations, 61.74% obtained Grade C or better (BEC, 2014). For the 2014 JCE mathematics examinations, only 24.5% obtained Grade C or better (BEC, 2014). Even though this is the case, it seems the validity of PSLE grades in predicting JCE grades is not taken into account when contributing factors to poor performance in mathematics are put forward. The PSLE results play a vital role in junior secondary education. The teachers' performance in the teaching of mathematics at JC is assessed using the grades the students' obtained in PSLE as a baseline. Thus, if the student

obtained a higher grade in Junior Certificate of Education examinations than in Primary School Leaving Examination, the teacher is considered to have added value to that student's performance and if the student has obtained a lower grade, it is considered that the teacher failed to maintain or add value to the student's performance and has to fully account for the student's drop. The teachers promotions are based on how their students performed in JC examinations compared to how they performed in PSLE. Therefore, for PSLE grades to be used confidently as a baseline for students' performance at JCE level; they should be subjected to testing and validation.

The percentages of candidates awarded Grade C or better in mathematics were as follows: in 2012 was 33.9%, in 2013 was 28.7% and in 2014 it was 24.5% (BEC, 2014). These percentage shows that the performance of junior secondary school students in mathematics is still very poor. Each year the mathematics results drop by approximately 5%, which reveals a drastic decline in students' academic achievement.

With this picture, it is crucial to establish the validity of PSLE results in predicting performance in JCE. In Botswana, researchers seem to have not done much work in validating PSLE examination results. Therefore this study intends to compare the predictive validity of 2012 and 2013 JCE mathematics results using the 2009 and 2010 PSLE mathematics grades to determine whether or not PSLE grades could effectively predict students' performance in JCE mathematics. Gender of students and location of the school will also be taken into consideration during the analysis of the results.

Gender and Mathematics Performance

Another issue of concern is the trend in gender and mathematics performance in junior secondary schools. Female students tend to perform better in mathematics than their male counterparts at JCE level. Earlier, it was well known that female students outperform

male students in mathematics at lower primary when the assessment is based more on computational knowledge (Gallagher & Kaufman, 2005). At JCE level, where the mathematical concepts are spatial in nature, male students performed better than the female students (Gallagher &Kaufman, 2005). For the past three years in Botswana, the female students at junior certificate level performed better than male students in mathematics. The percentages for those who obtained grade C or better in the past three years according to gender are shown in the Table 1.

Table 1:

A, B and C Grades per Gender in JCE Mathematics Examination in 2012, 2013 and 2014 (Source: BEC)

Years and grades	Females (%)	Males (%)
2012		
A	4.0	4.1
B	10.0	8.6
C	22.9	20.3
2013		
A	3.2	2.8
B	8.8	7.0
C	19.9	15.6
2014		
A	3.6	3.1
B	8.8	6.5
C	15.5	12.2

Table 1 shows clearly that the trend is somewhat changing. The differences between the percentages for female students and male students in A, B, and C grades show that in recent years female students are performing better than male students in mathematics at JCE level.

Location and Mathematics Performance

Despite the efforts being made towards ensuring that students in both rural and urban areas have equal educational opportunities so as to improve their academic performance in both internal and external examinations, the observation is that the students in rural areas

continue to perform poorly as compared to their counterparts in urban areas. The percentages for those who obtained Grade C or better in the 2014 JC mathematics examinations according to location are shown in Table 2.

Table 2:

Grade A, B and C in 2014 JCE Mathematics per Urban and Rural Areas (Source: BEC)

	Urban	Rural	Urban	Rural
Grades	South East (%)	Kgalagadi (%)	North East (%)	North West (%)
A	6.27	0.82	4.91	1.34
B	10.55	4.22	9.76	3.62
C	18.24	6.78	17.40	9.01

Table 2 shows clearly poor performance in mathematics in rural areas as compared to urban areas.

Background

Historical Overview of Education in Botswana

The formal education in Botswana was first provided by London Missionary Society in the 19th century and during that time there was no education policy to be used in the implementation of educational programmes and the general supervision of schools (Monyaku & Mmereki, 2007). After gaining independence in 1966, Botswana introduced education policy and to date there has been two major education policy reviews (Monyaku & Mmereki, 2007). The first National Policy on Education (1977) was a significant milestone, as it provided a sound framework for educational planning and provision of education (UNESCO, 2006). The Revised National Policy on Education (1994) recognized the goal of education as setting up Botswana for transition from traditional based economy to an industrial economy to enable competition with other countries of the world. The RNPE (1994) identified the

main objective of the MoE as raising educational standards at all levels and emphasizing science and technology in the educational system.

After gaining independence, Botswana also made a tremendous improvement in educational development. The discovery of diamonds after independence boosted the government revenue which led to among others, an increase in educational provision in the country. This development enabled all students' access to ten years of basic education leading to a junior certificate qualification. In 1997, after a long process of consultation with other stakeholders, Botswana finalised the Long Term Vision (Vision 2016) which emphasizes that by 2016, Botswana will have a system of quality education that is able to adapt to the changing needs of the country as the world around us changes. Vision 2016 also highlights that all Batswana will have the opportunity for continued and universal education.

The Structure of the Education System in Botswana

Education has grown dramatically since independence (NCE, 1977). Botswana made a tremendous achievement for the past five decades to make schooling accessible to many young Batswana. All children of school going age in Botswana have the right to ten years basic education. According to the RNPE (1994), the adoption of the National Policy on Education (1977) led to educational development that has been characterised by a massive expansion of school places. This is evidenced by large number of enrolments in primary schools, secondary schools and tertiary institutions. The infrastructure and manpower was also increased. The primary schools increased from 250 in 1966 to over 770 schools, with the number of teachers rising from 1624 to over 12 000 (Monyaku & Mmereki, 2007) . The secondary schools also increased from nine in 1966 to over 240, with the teaching staff growing to over 9000. However, the success in quantitative development of the school system has not been adequately matched by qualitative improvements (RNPE, 1994). Levels

of academic achievement are an issue for discussion across all levels. There is drastic decline in performance in both levels of secondary education, especially in mathematics.

The National Policy on Education (1977), on the recommendation of the First National Commission on Education adopted a change in the structure of education from 7 years of primary school, 3years of junior secondary and 2 years of senior secondary (7+ 3 + 2) to 7 years of primary school, 2 years of junior secondary school and 3 years of senior secondary school (7 + 2 + 3). The 7 + 2 +3 structure was introduced in 1986 and the first group to sit for two- year junior certificate was in 1987. According to the RNPE (1994), the reasons for this transitional stage were that it would enable the attainment of universal access to nine years of basic education quicker and that an extra year of senior secondary schooling would significantly improve performance of the Form 5 leavers. After running for some few years, the structure was seen to have some problems. Firstly, the 2- year junior secondary education period was considered too short for effective teaching and learning to take place especially taking into consideration the wide range of abilities of students. Secondly, the employers and training institutions considered the standard of achievement at junior certificate level questionable and did not accept it as equivalent to the former three -year junior Certificate. Lastly the students were completing junior certificate level while their ages were below the minimum employment age. Therefore, the 7 + 3 + 2 was reintroduced, and the first group to sit for the 3-year Junior Certificate examination after the reintroduction was in 1998.

Currently, the education of Botswana consists of seven years of primary education. This level is divided into two sub-levels; lower primary which is standard one to standard four, and upper primary which is standard five to standard seven. At the end of standard four pupils sit for national examination called Standard Four Attainment Test, which determines whether the pupils proceed to upper primary (Monyaku & Mmereki, 2007). At the end of

upper primary (at standard seven), the pupils sit the Primary School Leaving Examination. PSLE is a diagnostic test and does not necessarily determine transition into junior secondary because all students are expected to continue into the last three years of the ten year basic education. The role of PSLE is to identify weaknesses in students' achievement so as to assist the teaching and learning processes at JC level (UNESCO, 2006). Therefore, after PSLE all students proceed to form one through to form three to complete their ten years basic education. At the end of form three the students take Junior Certificate Examination whose role is to select the students into senior secondary school and to assess the extent to which basic competencies and skills have been acquired (UNESCO, 2006). The students sit for nine subjects but the overall grading is done based on seven subjects of which four are core and the other three that the students obtained best results on. The grades for the core subjects are used for the overall grading, regardless of how the students performed, these subjects are mathematics, science, Setswana and English.

Senior secondary school takes two years and students used to sit for COSC examination at the end. The RNPE (1994) recommended that the senior secondary school syllabuses and examinations be localised to cater for a wider ability group. In response to the recommendation, BGCSE was introduced in 2000 to replace COSC. After completion of senior secondary, individuals can enrol in vocational, technical or tertiary institutions to acquire life skills and professional qualifications, depending on performance in the Botswana General Certificate of Secondary Examination (BGCSE) or equivalent (Monyaku & Mmereki, 2007). The Botswana Examination Council (BEC) is responsible for the development, administration, accreditation and certification of both primary and secondary schools examinations. It was established in 2002 after a recommendation of the National Commission on Education, to provide direction on examinations' policy and to oversee the administration of examinations and the maintenance of standards of marking.

Background on Poor Performance in Mathematics

Poor performance in mathematics in Botswana has been a problem for some years. According to Botswana Performance Report on vision 2016 (2009), mathematics results in JCE were in the range 23% over a period 2003- 2005. The trend continued in the years that followed, for example, the percentage of students awarded grade C or better in mathematics was 23% in 2006, 22.8% 2007 and 21.8% in 2008 (BEC, 2008). From the percentages given, it shows that performance in JCE mathematics has long been a problem.

Even though the problem of poor performance persists, the RNPE (1977) emphasized that, while all curricular areas are important, fundamental competencies in mathematics are of special importance and indicated that the teaching of all subjects should reinforce the development of these basic competencies. The rationale for mathematics programme as outlined in the three- year junior secondary school mathematics syllabus is to equip students with basic knowledge, skills and attitudes that will enhance their prospects of employment and increase their ability to use mathematics in the solution of real life problems. The three-year JCE syllabus states that "Mathematics also plays a great role in society because of its widespread application in every sphere of life; in areas of science, technology, economy, agriculture, business and other social activities" (MoE &SD, 2008, p. i). Mathematics is very essential in many areas of our lives; therefore, the continual drop of the results at JCE level is a serious concern.

Theoretical Foundation

The Concept of Validity

Validity, which is one of the driving theories of this study, refers to the degree to which an assessment actually measures what it claims to measure and how well it serves the intended purposes (Herman & Choi, 2012). In mathematics, tests are used to measure various skills like knowledge of basic concepts, ability to recall concepts, ability to comprehend

concepts or ability to apply concepts to real to life situations. For test to be good it ought to have adequate evidence for its validity for the purpose it is used for and the persons with whom it is used (Kubiszyn & Borich, 2013). This is to say, assessment itself cannot be considered valid unless evidence of validity has been established in the context of specific interpretations and uses of test scores. A test may be well suited for one use and not for another, for example, a mathematics test appropriate for formative assessment purposes for teachers may not serve well summative purposes (Herman & Choi, 2012). Therefore, if a test is to be used in any kind of decision making, or if the test information is to have any use, three types of evidence that indicate tests' validity for the purpose it is being used for should be identified (Kubiszyn & Borich, 2013).

Content Validity Evidence

The content validity evidence for a test is established by inspecting test items to see whether they resemble what the test is designed to measure. The setback with the content validity evidence is that it gives information about whether the test looks valid, but not whether the reading level of the test is too high or if the test items are poorly constructed (Kubiszyn & Borich, 2013). A test in some instances may look valid but measure something entirely different from what it is intended. Such as skills like guessing ability, reading level, or skills that may have been acquired before instruction (2013). In mathematics, the test may look valid because it covered the instructional objectives, but with the requirement that the test should involve a good number of application questions; it is possible that some test items may not measure what they were intended to measure. Many application questions require students to apply their knowledge of the English language to understand the questions, therefore, for students who have challenges with the English language, the test becomes invalid. On the other hand, some terms that are used in the test can make the test invalid for students living in certain areas because they will not have an idea of what the term exactly

mean. To judge the validity of the test content, a hard look at the individual items should be done because it is the task presented by the items that really define what a test is measuring (Thorndike & Hagen, 1969).

Criterion-related Validity Evidence

In ascertaining criterion validity evidence, scores from a test are correlated with an external criterion. For example, this can be done by correlating PSLE mathematics grades with JCE mathematics grades. There are two types of criterion-related validity evidence, which are concurrent and predictive.

Concurrent Criterion Related Validity Evidence

Concurrent criterion-related validity evidence refers to measures that can be administered at the same time as the measure to be validated. The concurrent validity evidence of a test is established by administering both the new test and the set up test to a group of students, then finding the correlation between the two sets of test scores (Kubiszyn & Borich, 2013). The reasons for establishing the new test lies in most cases with issues of time and costs. For instance, the duration of mathematics JCE examination paper is two hours, if there is a feeling that this is too long, a new test that is shorter, which may be takes half of the time of the established test can be constructed and both test be given to students and a correlation coefficient between the two tests be calculated. If the same students rank similarly on both tests as indicated by a high correlation, the new test could be said to have concurrent validity.

Predictive Validity Evidence

Predictive validity evidence refers to how well scores from the test predicts some future performance of the examinees. It is determined by administering a test to a group of students, then measuring the students on whatever the test is supposed to predict after a

period of time has passed by (Kubiszyn & Borich, 2013). The two set of scores are then correlated, and the coefficient that results is called predictive validity coefficients. The higher the correlation between the test and a criterion the more confident we are about the worth of the test. For this study, if the correlation between PSLE mathematics scores and JCE mathematics scores is high then we will be convinced that that PSLE mathematics scores can be used to predict students' JCE mathematics results.

Construct Validity Evidence

Kubiszyn and Borich (2013) state that a test has construct validity evidence if its relationship to other information corresponds well with some theory. A theory is a consistent underlying principle that gives the explanation for the interrelationships among a set of variables. For instance, if a test is supposed to be testing algebraic skills, we expect scores on it to improve after intensive coaching in algebra but not intensive coaching in arithmetic computations. This is to say, any information that reveals whether the results from the test match up with what you would expect basing on your knowledge of what is being measured enlighten you about the construct evidence for a the test. Evidence of construct validity is established by techniques such as factor analysis and tests that are capable of distinguishing students with different abilities.

Validity of assessment results on the other hand is concerned with the soundness of interpretations and uses of students' assessment results (Nitko & Brookhart, 2011). To ascertain that interpretations and uses are valid, evidence must be sort from different sources that will confirm their appropriateness. However, what teachers need to note is that the concept of validity applies more to the ways we interpret and use the assessment results and not on the assessment procedure itself (Nitko & Brookhart, 2011). Thus, we cannot say "are the PSLE mathematics results valid?" Rather we should say "is it valid to use PSLE mathematics results to predict students' JCE mathematics results".

Assessment results have different degrees of validity for different purposes and for different situations (Nitko & Brookhart, 2011). The PSLE mathematics results for example, may be highly valid when used to predict the scores in JCE in some locations say urban areas and on the other hand, scores from the same PSLE mathematics may have poor validity for predicting JCE in rural areas. The scores can also be highly valid when used to predict the scores in JCE in male students than in female students or vice-versa.

Statement of the Problem

The poor and deteriorating performance in mathematics by students at junior and senior secondary school levels is a huge problem that bothers government, politicians, parents, students and teachers. The percentages of the students obtaining Grades A, B, and C is going down every year (see Table 1). The Report of the National Commission on Education (1977) stipulates that for the three years of junior secondary school cycle, the learners should have thorough competence in all basic arithmetical operations; development of basic mathematical reasoning and problem solving with practical and real-world orientation. Despite the stipulations of the RNPE (1977), the students' performance in mathematics continues to decline in JCE. When coming from primary schools the students come with better mathematics PSLE grades, but in most instances they fail to maintain or improve the grades at JCE level and instead they drop. The poor performance in JCE mathematics subsequently affects the BGCSE mathematics results. When making a commenting after the release of the 2013 BGCSE results, Tabulawa (2014) indicated that mathematics is the most failed core subject and stated that the continued poor performance in mathematics frustrates the government efforts to channel resources towards developing mathematics and science related fields like mining and engineering. He also pointed out that universities usually consider sciences together with mathematics for technical courses which means students might not make it into programs like Bachelor of Science and other science based subjects (Tabulawa,

2014). The three year junior secondary school syllabus (2008) clearly states that the mathematics programme will equip students with basic knowledge, skills and attitudes that will enhance their prospects of employment and increase their ability to use mathematics in the solution of real life problems. Given the continual deteriorating performance of students in mathematics at JC level it is evident that this objective is not achieved.

This persistent poor performance in mathematics raises the question of validity on PSLE grades. To be confident that the students' performance in mathematics drops drastically at JCE level, the predictive validity of JCE results using PSLE grades need to be established. The NCE (1977) recommended that the PSLE results be analysed to contribute to curriculum reform and improved teaching and as a means of improving the examination themselves. Currently, PSLE mathematics examinations comprises of 60 multiple choice questions and the trend in most schools is that standard seven is a year of revising, cramming and studying for an obsolete test (Molefe, Pansiri & Weeks, 2009). In this way, the examination results do not represent properly graduated differences in achievement (NCE, 1977). Some students obtain good mathematics grades in PSLE simple because they were drilled. The teachers put more effort in helping students pass the examination than helping them develop their understanding and knowledge of mathematics. They spend the whole year doing it, even using past examination papers as tools for revision (Molefe, et al., 2009). Therefore, the results some students obtain are not a true reflection of their ability in mathematics. In view of this, the Botswana Examination Council has to enhance the validity of PSLE so that the examinations assess not merely memorization but also powers of application, observations, explanations and reasoning (NCE, 1977). BEC should consider using different forms of measuring mathematics competence instead of using multiple choice examinations only.

BEC on the other hand, designed and revised the JC mathematics assessment procedures in 2011 to align them with the RNPE (1994). The RNPE (1994) stipulates that the main intentions of the three year JC programme are to provide the learners with opportunities for prevocational preparation and to enable the learners to take advantage of further education and training. The range of ability of the learners in JSS has also influenced the design and revision of assessment procedures to ensure that all learners regardless of their ability have the opportunity of demonstrating what they know, understand and can do. Therefore, deterioration of JCE mathematics performance may be as a result of changing validity of the examinations across the years in trying to align them to the designed and revised assessment procedures. Even though poor performance in mathematics has long been a problem, the statistics shows that drastic drop occurred after BEC has designed and revised the assessment procedures. Thus, the percentage of the students who obtained C or better in 2012 was 33.9%, in 2013 was 28.7% and in 2014 it was 24.5% (BEC, 2014). This may in a way mean that the new assessment procedures have impacted on the validity of the JCE mathematics examinations.

As a result of the above state of affairs on PSLE mathematics and JCE mathematics, it then necessary to scrutinize the PSLE grades to establish if they are valid enough to predict the JCE grades.

Purpose of the Study

This study was conducted to investigate the quality and the persistence of the predictive validity of PSLE mathematics grades in predicting performance in JCE mathematics examination, considering the fact that a significant number of students achieve good PSLE mathematics grades, but perform poorly in JCE mathematics. The content in the mathematics syllabus is arranged in a spiral format from primary school level through junior secondary level. Year –in and year-out the students cover the same topics but the concepts

become more abstract as they move from one level to another, therefore the anticipation was that the students who did well at primary school would maintain or improve their grades at JCE level. The main purpose of this study is to determine the validity of PSLE mathematics grades in predicting students' performance in JCE mathematics. The study particularly focused on comparing the predictive validity of the 2012 and 2013 JCE mathematics results using 2009 and 2010 PSLE mathematics grades respectively.

The study intends to determine:

- The extent to which grades in 2009 and 2010 PSLE mathematics are valid at predicting performance in 2012 and 2013 JCE mathematics final examinations.
- The extent to which grades in 2009 and 2010 PSLE mathematics are valid at predicting performance in 2012 and 2013 JCE mathematics final examinations for both males and females.
- The extent to which grades in 2009 and 2010 PSLE mathematics are valid at predicting performance in 2012 and 2013 JCE mathematics final examinations for both urban and rural schools.

Research Questions

The following research questions will help in determining the predictive validity of JCE examinations results using PSLE grades among the male and female students among urban and rural schools.

- To what extent do students' grades in 2009 PSLE mathematics valid at predicting performance in 2012 JCE mathematics examinations?
- To what extent do students' grades in 2010 PSLE mathematics valid at predicting performance in 2013 JCE mathematics examinations?

- To what extent do students' 2009 PSLE mathematics grades valid at predicting performance in 2012 JCE mathematics examinations among males and females?
- To what extent do students' 2010 PSLE mathematics grades valid at predicting performance in 2013 JCE mathematics examinations among males and females?
- To what extent do students' grades in 2009 PSLE mathematics valid at predicting performance in 2012 JCE mathematics examinations among urban and rural schools?
- To what extent do students' grades in 2010 PSLE mathematics valid at predicting performance in 2013 JCE mathematics examinations among urban and rural schools?

Research Hypotheses

- The students' 2009 PSLE mathematics grades are significantly valid at predicting performance in 2012 JCE mathematics final examinations.
- The students' 2010 PSLE mathematics grades are significantly valid at predicting performance in 2013 JCE mathematics final examinations.
- The students' grades in mathematics in 2009 PSLE are significantly valid at predicting performance in 2012 JCE mathematics examinations among males and females.
- The students' grades in mathematics in 2010 PSLE are significantly valid at predicting performance in 2013 JCE mathematics examinations among males and females.
- The students' grades in 2009 PSLE mathematics are significantly valid at predicting performance in 2012 JCE mathematics final examinations among urban and rural schools.
- The students' grades in 2010 PSLE mathematics are significantly valid at predicting performance in 2013 JCE mathematics final examinations among urban and rural schools.

Significance of the Study

This study would be significant as the findings would reveal clearly if PSLE mathematics results are valid at predicting the mathematics performance at JC level or not. In view of the fact that the study would model the mathematics PSLE/JCE prediction

equations this will give teachers an insight of how students who got particular grades at PSLE would perform at JCE and as such be able to sort appropriate interventions of improving their performance. These results would not only benefit the teachers, all stakeholders such as school administrators, parents, students, examination council and curriculum developers would know how the mathematics PSLE grades correlate with JCE mathematics grades and therefore intervene accordingly to try to deal with the problem of poor performance in mathematics.

The results of this study will clearly reveal to the Botswana Examination Council the validity level of PSLE mathematics grades at predicting JCE mathematics grades. This will therefore enable them to take the right decisions as far as ensuring validity of PSLE examinations grades is concerned. The teacher training institutions both for primary and secondary would use the results as a basis to start equipping teachers with necessary skills that can help them improve the continual declining mathematics results. The Ministry of Education and Skills Development would through these results intensify more efforts to ensure that there is better teaching and learning strategies in schools and ultimately improved results.

The study will also show the prediction equations for gender and location. If the equations are significantly different then it would mean there are somehow no equal opportunity of quality education and fair distribution of the resources to students of different genders and locations. The MoE&SD would then intervene to see to it that equity is taken into consideration when instruction is delivered to students. The ministry would also ensure that there is fair distribution of resources across the different regions.

Assumptions

Assumptions are important assertions presumed to be true but not actually verified (Fraenkel & Wallen, 2006). The researcher assumes that the students who obtained better grades in PSLE mathematics would perform well in JCE mathematics. It is also assumed that the 2009, 2010 PSLE and 2012, 2013 JCE mathematics results are valid and reliable and therefore can be used to draw valid conclusions. The other assumption is that the examinations were given under supervised conditions where examination rules were precisely followed. The researcher also assumes that the students covered all the material that they were assessed on.

Limitations

This study will only use PSLE mathematics grades as predictor variables in determining the JCE mathematics results, therefore, the results will have a major limitation as there could be other factors that contribute to mathematics performance like students' attitude towards learning, absenteeism from school due to fee or discipline problems, students' socio economic background, students' motivation and interest in the learning process. The other factors that contribute to achievement in mathematics could not be measured in this study since the data that are used are only the scores of candidates who sat for JCE in 2012 and 2013. Therefore to reach those candidates to solicit other factors that contribute to achievement in mathematics may not be possible as some are now in different senior schools doing form five, others in different places as they did not make it to senior school and some all over the country as they have already completed form.

Delimitation

The study will confine itself to comparing the mathematics PSLE results and mathematics JCE results as a way of establishing validity. Time constraints will not allow the

researcher to look into the 2009 and 2010 PSLE mathematics examination items to verify their validity as they might be causes of invalidity.

VALIDITY OF PSLE PREDICTING JCE MATHEMATICS

Definition of Terms

Prediction is the process of forecasting or making a statement about the future based on facts and evidence.

Validity is the act of being logically or factually sound.

Primary School Leaving Examinations (PSLE) are the tests or assessment given to the students at the end of seven years of their primary school education.

Junior Certificate of Examinations (JCE) are the tests or assessment given to the students at the end of three years of their junior secondary school education.

CHAPTER 2

Literature Review

Introduction

The study intends analyse the predictive validity of the Junior Certificate mathematics grades using the PSLE mathematics grades. As part of this effort, the review of literature will focus on predictive validity of examination results and mathematics performance by gender and location.

Predictive Validity of Examination Results

Faleye and Afolabi (2005) conducted a study to find out whether there is a significant relationship between the overall performance of students in Junior Secondary Certificate Examination (JSCE) and their performance in the Senior School Certificate Examination (SSCE). The researchers also intended to determine the nature and strength of the relationship between selected JSCE subjects and their corresponding equivalents in Senior Secondary School 1 aggregate (SSS 1), Senior Secondary School 2 aggregate (SSS 2) and SSCE. In this study, promotion scores of the students in SSS 1 and SSS 2 as well as their SSCE were compared with corresponding JSCE scores using correlation analysis procedures. The sample of study consisted of students from six purposefully selected secondary schools in Osun State, Nigeria, thus top three schools of science and the other three public schools. The study initially involved all students who took 1993 JSCE but the final analysis was done on 505 students whose results were obtainable and intact.

The examination scores of the students were obtained from school records in six JSCE subjects, which were English language, mathematics, integrated science, Yoruba language, social studies and agricultural science. The promotion examination results of students in SSS 1 and SSS 2 and their final SSCE results were also obtained in school subjects corresponding to the selected JSCE so that comparison can be done.

In determining the relationship between 1993 JSCE results and corresponding scores of the candidates in SSS 1, SSS 2 and SSCE, the results revealed that only two schools had JSCE performances that were significantly related to their SSS 1 aggregate results, thus $r = .20$, $p < .05$ and $r = .24$, $p < .05$ and other schools had positive but non-significant r values. On the other hand two other schools had students with significant correlations between their JSCE and their SSS 2 aggregate results, that is $r = .36$, $p < .05$ and $r = .35$, $p < .05$. For correlations of JSCE scores and SSCE three schools had significant correlations coefficients, thus $r = .26$, $p < .05$, $r = .32$, $p < .05$ and $r = .44$, $p < .05$. Generally for all the comparisons done, the correlations were low and showed little predictive ability between the independent variable and the dependent variables.

For the correlation between selected subjects in JSCE and corresponding subjects in SSS 1, SSS 2 and SSCE the results showed that there is low but significant correlations between JSCE and SSS 1 English language ($r = .333$, $p < .05$), SSS 2 English Language ($r = .306$, $p < .05$) and SSCE English Language ($r = .319$, $p < .05$). Likewise, correlation in JSCE mathematics and SSS 1 mathematics ($r = .303$, $p < .303$), SSS 2 mathematics ($r = .287$, $p < .05$) and SSCE mathematics ($r = .219$, $p < .05$) were low but significant. The correlations that exist between JSCE subjects and SSS 1, SSS 2 and SSCE in all the cases were low and therefore showed slight predictive ability.

The study further presented the results of the students in the JSCE and comparative performance of the same students in the same subjects in SSCE. The results showed that of the 91 students who obtained Grade A in JSCE English 18 of them maintained Grade A in SSCE English, 60 obtained Grade C, 13 obtained Grade P and none got Grade F. Thus, 85 % of the students who obtained Grade A in JSCE obtained distinction in SSCE English. On the other hand, 93% of the students who obtained Grade P and F in JSCE maintained the same Grades in SSCE English. The same pattern was observed in mathematics and integrated

science. Contrary to other subjects, in agricultural science 60% of those who failed agricultural science in JSCE did not fail it in SSCE and 66% of those who obtained Grade A in JSCE maintained the same grade in SSCE agricultural science.

The inter-subjects performance of the students in JSCE and SSCE was also analysed and the results showed that 56.9% of the students who obtained Grade A in JSCE subjects maintained the same grade in SSCE subjects. 70% of the students who obtained Grade C in JSCE obtained Grade C or better in the SSCE and only 59.4% of the students who obtained grade F in JSCE got the same grade in the corresponding subjects in SSCE.

Generally the results for this study revealed that Osun State JSCE is a poor predictor of students' performance in SSCE. This finding was in line with the finding of Edokpayi and Suleiman (2011) who found that students' academic performance in integrated science was a poor predictor of later achievement in chemistry at senior secondary school certificate. Nevertheless, JSCE English language and mathematics were found to have a higher capability to predict performance in SSCE English language and mathematics than other subjects. For mathematics, the results corresponded with the findings of Wushishi and Usman (2013), who found that there is a significant relationship between Western Africa senior school certificate examination (WASSCE) entry grade in mathematics and the final Nigeria certificate of education mathematics results. According to Faleye and Afolabi (2005), the predictive capacity of the JSCE could be affected by the quality of the examination questions and the procedures of the administration and scoring of the examinations. The researchers indicated that in most States the examination questions often leak and teachers in each school are also made to invigilate their own students. Faleye and Afolabi (2005) also posit that the awarding of marks is not done in a far manner, especially the continuous assessment. The researchers pointed out a number of factors that have the potential of affecting the predictive validity of test items. These are factors affecting the test reliability and factors relating to the

test itself like the nature of test items, their psychometric properties of discrimination and distracter abilities as well as the homogeneity of the items.

Another study was done by Adeyemi (2008) in Nigeria whose aim was to examine the predictive strength of the Junior Secondary Certificate (JSC) examinations in predicting the performance of students in the Senior Secondary Certificate (SSC) examination in Ondo State. The researcher's intention was to determine the effectiveness of the performance of students in JSC examination in predicting the performance of the same students in SSC examination. The study was in a form of correlational research whose population was all 257 secondary schools who had registered the JSC examinations' candidates in the year 2000 and SSC examinations' candidates in the year 2003. The population was comprised of 110 urban schools and 147 rural schools. The sample covered 13 single sex schools and 244 mixed schools. A sample of 218 schools was selected from the population of study using the stratified random sampling technique, taking into account the location of the school. The sample consisted of 94 urban and 124 rural secondary schools. The representation of the rural secondary schools in the sample was high than those of the urban schools and this can in a way have affected the validity of the results. The researchers could have opted for the sampling method that could try to balance the schools in the sample according to the locations.

The researcher used the inventory to collect data for the study. The information that was needed on the inventory was data on enrolment figures and students' grades English language, mathematics and integrated science in the 2000 JSC examination as well as students' grades in English language, mathematics, physics, chemistry and biology in the 2003 SSC examination. The subjects were selected basing on the fact that they are regarded as core subject in the secondary school curriculum in accordance with the National Policy on

Education. The statistical analyses used were z-test statistics, correlation analysis and multiple regressions.

The general predictive validity of the study was significant but the performance varied noticeably from one subject to another. In English language, the results showed a significant relationship between students' performance in JSC examination and students' performance in SSC examination. The results for mathematics showed that there is no significant relationship between students' performance in JSC examination and SSC examination. There was also no significant relationship between students' performance in integrated Science JSC examination and students' performance in Physics SSC examination. Other significant relationships were observed between students' performance in JSC examination in integrated science and the students' performance in SSC examination in both chemistry and biology. The analysis of the results also shown that the best predictor of performance of the same students at the SSC examination in Ondo State was JSC 2000 English language which contributed 45% to the criterion variable. The comparative effects of the JSCE 2000 on SSEC 2003 showed that the probability was less than.05 in the overall performance of students in English, chemistry and biology. This therefore showed that there was a significant relationship between all the predictor variables and the credit performance of the students in the 2003 SSC examination. 24% variance was predicted by the variables in the overall performance, 23% of variance was predicted in English language, 18% in mathematics, 21% in physics, 25% in chemistry, and 23% in biology. These results indicated clearly that JSC performance was rather low predictor of academic performance in SSC examination.

Jarego (2013) also carried out a study to determine whether performance in Kenya Certificate of Primary Examination can predict performance of the same students in Kenya Certificate of Secondary Examination when provided with the same educational facilities and inputs. The

other objectives of the study was to examine whether girls and boys performance in KCPE differ in predicting their performance in KCSE. Ex post and correlation designs were used in this study to analyse data. Since the target group was small, the researcher used the entire 110 students in a medium cost private mixed secondary school in Western Kenya in his study. There were 28 girls and 82 boys who took part in the study. The number of girls is much lower than that of the boys, but to rectify this problem the researcher examined whether there is a gender difference in predicting performance in KCSE using performance in KCPE.

The results show that the students' performance in KCPE is positively correlated to the students' performance in KSCE ($r = .599$, $p < .01$), this therefore indicate that students who performed well in KCPE are likely to perform well in KCSE. These results were consistent with the findings of Othuon and Kishor (1994) who found that the Kenya Certificate of Primary Education scores had a moderate positive linear relationship with the Kenya Certificate of Secondary Education grades. The results also revealed that performance in KCPE is a major predictor of their performance in KCSE ($\beta = .236$, $t = 7.010$). On examining whether performance of girls and boys in KCPE differ in predicting their KSCE the results shows that girls though they were admitted with lower marks ($M= 373.00$) in KSCE they perform better ($M = 62.2143$) than the boys (61.8049) in KCSE. This therefore showed that if girls can be given the same educational inputs and same environment as boys they could perform better than the boys.

Gender and Mathematics Achievement

The trend has been that boys outperform girls in mathematics, especially at higher schools. Currently the pattern is slowly changing. Kiptum et al. (2013) conducted a study to find out the relationship between gender of students and mathematics performance in primary schools in Keiyo South District, Kenya. The aim of the study was to establish whether or not

attitudes of female students towards mathematics differ significantly from those of the male students. The population of study was the standard eight learners and mathematics teachers from Keiyo South District. The sample of study was 500 students and 50 mathematics teachers from 50 primary schools randomly selected from 119 schools in the district. The 50 schools in the sample involved mixed sex day schools, male boarding schools and female boarding schools.

The common activities in this district are farming and cattle keeping which is done by males, therefore the study seek to investigate the sociological factors influencing primary school learners' attitude towards mathematics. A survey was used for this study and data was collected using researcher designed questionnaire, interview schedules and class examination results administered previously. Descriptive statistics involving the use of frequencies and percentages was used to analyse data. Multiple regressions were used to make inferences on the relationship between dependent variable and independent variables.

The findings of this study showed that more girls (13.7%) than boys (7.3%) indicated that they dislike mathematics. The response for girls was thought to explain their decline in performance in the subject over the years. The results further showed that most of the students, both boys (46.7%) and girls (45.7%) have positive attitude towards learning the subject. However, the results revealed that there were more girls who had negative attitude towards learning of mathematics and perceived that their peers do not regard mathematics as an important subject. The boys on the other hand were inclined to more positive attitudes towards the subject.

From these results the researchers inferred that the attitude of respondents towards mathematics was dependent on their gender. They also concluded that the value of mathematics the students attach to their future career in the modern technological world

affected their attitudes towards learning the subject. The sample of study used three types of schools but in the analysis of the results it was not mentioned how the type of school seemed to influence the mathematics performance. The patterns of attitude towards mathematics in mixed sex day school, male boarding school and female boarding might differ, but the researchers did not give any picture on how students in such schools perceived mathematics.

Maliki, Ngban and Ibu (2009) also conducted a study to look at the influence of sex, school location and school type on the academic achievement of secondary school students in mathematics. The study sought to provide data on the performance of students in mathematics tests as it relates to sex (males or females), school location (urban or rural) and school type (private or public). The population of study was 12 436 who sat for 2006 JSSCE in Bayelsa State in Nigeria. A sample of 600 students, 300 males and 300 females was randomly selected from the population of study.

The instrument used for data collection was a one hour multiple choice of mathematics ability test. The findings of the study showed that the male students' mean (M = 29.93) was higher than the female (M =27. 93). The results further revealed that students from rural school (M =31.81) perform higher than those from urban schools (M =25.36). On school type and performance the results showed that students from private schools (M =30.11) performed higher than those from public schools (M= 27.83).

Hannula (2009) also carried out a study to examine the influence of achievement, gender and classroom context on student's mathematical beliefs. The sample of study was selected from 50 randomly chosen Finnish speaking upper Secondary Schools from all over Finland. The participants who were 1436 in number were in their second year course for mathematics in Grade 11. The sample was chosen from 65 classes, of which 26 were doing

general mathematics and 39 doing advanced mathematics. The researcher used a questionnaire to collect data.

Exploratory factor analysis was run and seven factor solutions that account for 59% of variance and that provide factors with excellent internal consistency were obtained. Three factors were related to personal beliefs since a clear self relation aspect regarding competence, effort and confidence can be found (Hannula, 2009). Two factors were related mainly to social context variables that is teacher quality and family encouragement. One factor was related to one or more emotional expressions concerning enjoyment of mathematics and one to mathematics as a subject, that the difficulty of mathematics. The researcher therefore performed general linear model univariate on SPSS. The correlation between the factors was also done.

The results showed that there were several statistically effects. The results further shown that students' mathematical belief corresponded to the mathematical grades they had. All correlations ran were positive except correlation between grade and perception of difficulty of mathematics (Hannula, 2009). As regards to gender differences, the GLM univariate analysis indicated that for both advanced and general syllabus female students were less confident and they perceived teacher quality lower and mathematics more difficult than male students. The effect was strongest in self-confidence. Furthermore, there was a gender and group interaction effect for enjoyment among advanced mathematics courses, indicating stronger group effect for female students. All in all the results revealed that gender had a stronger influence on confidence in mathematics than mathematics grade. The same trend was observed on perception of mathematics difficulty in advanced course. Therefore, the conclusion was made that the beliefs the students have about mathematics are truly gendered.

School Location and Mathematics Achievement

School location has great influence on students' achievement in mathematics. Omenka and Kurumeh (2013) carried out a study to investigate the influence of gender and location on junior secondary school students' achievement in number and numeration in Benue State in Nigeria. Specifically, the researchers wanted to determine if gender affects students' achievement in number and numeration when taught using Ethno mathematics approach. The researchers also wanted to determine if location affects students' achievement in number and numeration when taught using Ethno mathematics. Ethno mathematics approach focuses on the use of materials within a given cultural setting (Omenka & Kurumeh, 2013).

A sample of 175 students was selected from two local government areas of Obi and Oju. The design of the study was quasi experimental design as the study seeks to establish the cause and effect relationship between Ethno mathematics approaches and gendered and location of the school. A 30 multiple choice test items on number and numeration was administered before and after teaching using ethno mathematics approaches. Mean and standard deviation were used to find the extent to which gender and location influence achievement in numbers and numeration when taught using ethno mathematics approach. The null hypotheses were tested at 0.05 level of significance using Analysis of covariance.

The findings of the study showed that mean gain of urban students (m= 6.44) taught using ethno mathematics is higher than that of the rural students (m = 0.1) taught using Ethno mathematics. However, the analysis further revealed that there is no significant difference in the mean achievement scores of students from urban and rural areas that were taught number and numeration using ethno mathematics approach. The results also shown that there is no

significant difference in the mean achievement scores of male and female students taught using ethno mathematics approach.

William (2005) also conducted a study to understand in an international context the extent of rural achievement gaps in mathematics among 15 year olds in 24 mostly industrialized nations of the Organisation for Economic Co-operation and Development (OECD). Specifically the researcher wanted to find the extent of the international pattern of rural disadvantage in mathematics achievement, how mathematics scores differ between rural and nonrural locales in each of the countries for which comparable data are available, the distinct national patterns of rural/nonrural achievement and the extent to which the differences in rural achievement can be explained by differences in the socioeconomic levels of rural versus nonrural students.

The data source is PISA 2000, the Programme in International Student Assessment 2000, collected by the Organisation for Economic Co-operation and Development (OECD). PISA 2000 collected data in 32 countries, with national student samples ranging from 300 to 10,000 students for a total of 265,000 students. This study used 24 nations out of 32 because for the other 8 nations all the comparable data for the study was not available.

The findings of the study showed that the U.K. has the highest average achievement of rural students in this sample, followed by Finland, New Zealand, Japan, Belgium, and Australia. These differences in the U.S., however, are only marginally significant statistically ($p = .068$) (Williams, 2005). The results showed that the rural-medium size achievement gaps were statistically significant in 12 of the 24 countries and in all countries except the U.K., rural achievement scores were lower in rural areas than in medium-size communities. The results further revealed that mathematics achievement gaps were more pronounced between rural and urban communities, where 11 out of 24 countries showed statistically significant

differences. In three countries—Belgium, the U.S., and Ireland—rural scores were higher, on average, than urban scores. In Belgium in particular, rural scores were one standard deviation higher than urban scores (William, 2005). It was also shown in the results that in the U.S., rural scores were more than one third of a standard deviation higher, though, again, the differences were only marginally significant. More commonly, students in urban areas scored higher than students in rural areas. The general picture in this study is that rural students scored lower in mathematics than nonrural students in most, but not all, countries. These results were consistent with the findings of Oluchukwu (2011), who found that there was a marked difference in the performance in urban and rural schools at senior secondary certificate examination with impressive mean scores obtained in urban schools. The observation made is that there are different patterns of achievement, in some countries, the lowest average scores are among rural students; in other countries, the lowest scores are among urban students. Only in Britain do rural students score highest, although the margin is not great and the U.S. also shows marginally significant differences between the mathematics scores of students in rural and medium-size communities and between urban and rural students, with urban students scoring the lowest (Williams, 2005).

Summary of Literature Reviewed

The literature that was reviewed was for the studies that were done in different countries around the world. On reviewing studies determining predictive validity, variations were observed across countries in subjects and educational levels for which predictive validity was done. In Kenya, the students' performance in Kenya Certificate of Primary Examinations was positively correlated to students' performance in Kenya Certificate of Secondary Examination, which therefore means KCPE results can be used to predict performance in KCSE. Some subjects in studies reviewed on predicting senior secondary

school examinations using junior secondary school examinations, showed a higher capability to predicting results in senior secondary school and others showed poor prediction levels.

In one study, students' mathematics results in junior secondary school examination was found to have a higher capability of predicting performance in senior secondary school examination, whereas in the other study, there was no significant relationship in students' performance in junior secondary school examination and senior secondary school examination. English language showed a significant relationship in predicting senior secondary school examination using junior secondary school examination results in both studies reviewed on prediction of senior secondary school examination results using junior secondary school results. These differences across countries and subjects may be brought about by the variations in monitoring external examination by examination bodies in different countries. The differences observed in different subjects may also be due to test items' validities and reliabilities. As such, this study will look at ways in which validity of mathematics examination items are ensured at both PSLE and JCE.

It was also established from literature that male students outperform female students in mathematics. The studies revealed that female students have negative attitude towards learning mathematics while the male students have positive attitudes. The literature reviewed also showed that female students were less confident and perceived mathematics more difficult than male students. Considering that the findings of different studies on gender and performance in mathematics were parallel, this study will compare the predictive validity index of males and females of PSLE mathematics results on JCE mathematics results and sensitize teacher training institutions and the department of teacher training and development accordingly. The results of this study will enable the curriculum developers to look critically into the issue of gender equality in both the curriculum and the textbooks used. After having a picture of predictive validity index of males and females of PSLE mathematics results on

JCE results, both BEC and teachers will be burdened with the task of ensuring that the mathematics assessment is not gender biased. The questions in the examinations should be fair for both males and females.

On location and performance in mathematics, the study on teaching numbers and numeration using ethno mathematics has shown that the mean gain of urban students was more than that of rural students but there was no significant difference in the mean achievement scores of students from urban and rural. In other studies the rural students' scores were generally lower than urban students' in mathematics. Unique cases were observed in Britain and in United States, in Britain, rural students scored highest in mathematics and in U.S. urban students scored the lowest in mathematics. The predictive validity index for rural and urban schools of PSLE mathematics results on JCE mathematics that will be obtained in this study will give the Ministry of Education and Skills Development a picture on whether there is fairness in the distribution of resources and therefore act accordingly. On assessment, the results of the study will enable BEC to ensure that the examination questions are not in any way disadvantaging students in either of the two areas, by probably using the items or objects that they are not familiar with in application questions.

Looking at what has been done by other researchers in the past to find solutions to poor performance in mathematics; this study needs to be conducted because the problem still persists. The study intends to inform the MoE&SD that assessing subsequent student performance is a powerful tool for assessing examination validity (Martin & Jolly, 2002). If the PSLE grades cannot predict JCE grades in mathematics, their validity will be questionable and as such relevant measures shall be taken to sort out the problem. Poor performance in mathematics might be emanating from how students are taught mathematics at primary school or it might be caused by the examination items or the type of examination

that is given. If the causes of poor performance in mathematics are identified at the lower level of the students' learning, rectifying the problem might not be very difficult.

CHAPTER 3

Research Design and Methodology

Introduction

This chapter presents how the research is going to be carried out operationally to find answers to the research questions outlined earlier in chapter one. It clarifies the research design of this study as well as how the sample population of the study was chosen from the target population. This chapter also focuses on the instruments that would be used to collect data and how the data collected would be prepared for data analysis.

Research Paradigm and Orientation

The study is guided by the positivists' paradigm. The paradigm emphasizes on that facts are revealed by observing nature without bias and recording findings as they are without the interference of the researcher's opinions. The problem of the current study calls for the quantifications of the validity of mathematics PSLE grades in predicting mathematics JCE grades.

Positivists' believe that reality exists objectively and independently from human experiences (Mentzer et al., 1995). They assume that the truth is independent; human beings must search for the truth devoid of their own thinking. This paradigm is vital because it highlights that there should be no subjectivity in searching for the truth and that the truth can be attained by objective mind where accurate measurements are used. Positivists indicate that it is vital to collect verifiable empirical evidence in support of theories and hypothesis. In this study, the 2009 and 2010 PSLE mathematics grades will be used to model the simple linear regression equations that predict performance for 2012 and 2013 JCE mathematics results and comparisons be made. Positivists hold that scientific knowledge should allow verification

or falsification and seek generalizable results (Cohen, Manion & Morrison, 2010). Therefore, this paradigm is relevant to this study since data would be collected from sample population and then generalization be made for the entire population of study.

Quantitative research is suitable for this study because data on the above mentioned factors will be collected from the sample and the relationship between independent and dependent variable determined using regression analyses. Getting statistical findings of the study will help in soliciting the precise solution of the problem, since they clearly show the relationships between the variables. Quantitative research orientation establishes associations between variables; therefore it is suitable for this study because the investigations between the independent variables and JCE mathematics performance were done to come up with accurate estimation of the relationships between the variables.

Research Design

This study was informed by the positivist paradigm. Positivists contend that the role of the researcher is to hypothesise about the nature of the world and find data that confirms or disconfirms one or more posited hypotheses (Easterby-Smith, Thorpe & Rackson, 2012). Assumptions are made that if the students had obtained particular grades in PSLE mathematics examination they should maintain the same grades or get high grades at JCE mathematics examinations; therefore with this paradigm guiding this study the truth will be revealed.

This study employed quantitative research method. In this method, investigators are interested in drawing inferences or generalizing from a sample of observations to a broader population (Lankshear & Knobel, 2008). The quantitative was chosen because the researcher intends to measure and analyse statistically the factors under study and apply the results to a group larger than the one selected to be in the study (2008). This study investigated the extent to which PSLE mathematics scores are valid in predicting JCE mathematics scores. Since the

researcher will be measuring relationships between independent and the dependent variables, it is necessary to adopt quantitative research orientation. It is ideal to use this research orientation because it focuses more on comparing and expressing the relationship between variables.

The main objective of this study is to attempt to discover relationship between non-manipulated variables and make generalizations, therefore, survey inferential design was adopted. To answer the research questions, correlational research design was used. Correlation research design is the measurement of two or more factors to determine or estimate the extent to which the values for the factors are related or change in an identifiable pattern (Privitera, 2014). This design coupled with appropriate statistical methodology, allows researchers to make predictions about relationships between particular variables. Therefore, this method is chosen because the researcher intends to estimate the extent to which PSLE grades can predict JCE grades in mathematics. This design also allows for usage of existing data records, hence suitable for this study because the researcher used existing data of 2009 and 2010 PSLE and 2012 and 2013 JCE mathematics scores.

Population of Study

A population is a group of individuals, things or events with at least one common characteristic which distinguishes it from other groups (Best & Kahn, 2006). When choosing the population of the study it should be on the basis of their involvement in the problem under study (Spradley, 1985). The data for this study was obtained from Botswana Examination Council. The data were grades from all the students across the country who had sat for PSLE mathematics examinations in 2009 and 2010 and JCE mathematics examinations in 2012 and 2013. The population of study was made up of candidates who had sat for JCE mathematics examinations in 2012 and 2013 among all public secondary schools in both rural urban areas of Botswana. There were 37 402 and 37 088 candidates in 2012 and

2013 respectively. This population is from 207 government junior secondary schools. The demographic information included in the data is gender of candidates and schools attended. The information on the schools attended enabled the researcher to indicate whether the school is in rural or urban area.

Sampling Procedure

The study used simple random sampling so that every subject has an equal probability to be selected and the results can be generalized to the larger population (Borg & Gall, 1989). Random Number Generator (RNG), an internet based application, was used to select randomly the sample of study. Through this application, numbers are selected easily and quickly. The schools were listed according to centre numbers and the RNG was commanded to select 50 random centre numbers from a range of 1 to 207 schools. Every school from the population in both 2012 and 2013 had the same chance of being selected for the sample.

The Sample

Wiersma and Jurs (2009) define a sample as "a subset of the population which the researcher intends to generalize the results" (p. 325). Therefore a sample should be a true reflection of the entire population. The sample of this study consists of the grades of the students who sat for PSLE mathematics in 2009 and 2010 and JCE mathematics in 2012 and 2013. A sample is studied because it can be cumbersome to study the entire population of study. In this study, 50 JSS schools were sampled and each candidate in every school sampled, whose grades for PSLE mathematics were traceable across the primary schools was used. The sample is as presented in Table 3.

Instrumentation and Data Collection

The researcher used data from Botswana Examination Council (BEC). The marks that were collected from BEC are the 2009 and 2010 PSLE and 2012 and 2013 JCE for

mathematics. The instruments used to collect this data are the BEC standardized examinations that are administered to all candidates across the country. BEC is responsible

Table 3

Sample Representative across the Years

Year	N	*N*	Males	Females
2012	37 402	7 261	3 742	3 519
2013	37 088	8 033	4 060	3 973
Total	74 490	15 294	7 802	7 492

for setting, administration and marking of the examinations at the end of both primary and junior secondary schooling. Therefore, BEC ensures that setting, administration and marking are done following the set standards for guarantying validity. And as such, the marks that will be obtained from BEC are assumed to be valid.

Data Preparation

The study consists of four data sets, 2009 and 2010 PSLE and 2012 and 2013 JCE mathematics grades. Since the four data sets were separate, the researcher matched and entered the PSLE grades into JCE data to create two data sets that are 2009 PSLE into 2012 JCE and 2010 PSLE into 2013 JCE. The data was then entered into SPSS window, version 21. Coding was done for gender, location of school, schools and candidates' name. For gender, 1 was used for females and 2 for males. The sampled schools were allocated identification numbers from 001 to 050. For location of school, 1 was used for the schools in rural areas and 2 for schools in rural areas. The candidates were numbered from 1 to the last on the sample size. Students' JCE grades were recoded as follows; A= 6, B = 5, C= 4, D = 3, E = 2 and U = 1. The PSLE grades were recoded in the same way as JCE grades but up to E = 2 since there is no U grade at PSLE level. The grades were turned into numerical symbols to enable easy processing of data by SPSS.

Procedure for Testing the Null Hypotheses

SPSS Version 21 was used to analyse the data in this study. For all the hypotheses that were tested, the samples were in two data sets, the first set is 2009 PSLE and 2012 JCE mathematics grades and the second set is 2010 PSLE and 2013 JCE mathematics grades. Data for the two sets of data was analysed finding the Pearson correlation coefficient and regression coefficients. The regression equations for PSLE were determined by fitting the values of the appropriate parameters in the linear regression model. The predictor variable in the regression analysis was the students PSLE mathematics scores and JCE mathematics scores were criterion variable. The hypotheses to be tested are as follows:

Table 4:

Procedure for Testing Hypotheses

	Hypotheses	Nature and Type of Variables	Statistical Analysis
1.	The students' 2009 PSLE mathematics grades are not significantly valid at predicting performance in 2012 JCE mathematics final examinations.	2009 PSLE scores-independent continuous variables. 2012 JCE scores-Dependent continuous variable	Simple regression analysis
2.	The students' 2010 PSLE mathematics grades are not significantly valid at predicting performance in 2013 JCE mathematics final examinations.	2009 PSLE scores-independent continuous variables. 2012 JCE scores-Dependent continuous variable	Simple regression analysis
3.	The students' grades in mathematics in 2009 PSLE are not significantly valid at predicting performance in 2012 JCE mathematics examinations among males and females.	-2009 PSLE scores-independent continuous variables. -2012 JCE scores-Dependent continuous variable	Simple regression analysis
4.	The students' grades in mathematics in 2010 PSLE are not significantly valid at predicting performance in 2013 JCE mathematics examinations among males and females.	2010 PSLE scores-independent continuous variables. 2013 JCE scores-Dependent continuous variable	Simple regression analysis
5.	The students' grades in 2009 PSLE mathematics are not significantly valid at predicting performance in 2012 JCE mathematics final examinations among urban and rural schools.	2009 PSLE scores-independent continuous variables. 2012 JCE scores-Dependent continuous variable	Simple regression analysis
	The students' grades in 2010 PSLE mathematics are not significantly valid at predicting	2010 PSLE scores-independent continuous variables.	Simple regression

6.	performance in 2013 JCE mathematics final examinations among urban and rural schools.	2013 JCE scores-Dependent continuous variable	analysis

Ethical Considerations

Data collection did not intrude into the participants' privacy. The PSLE and the JCE examination marks of the students were kept confidential and number codes were used instead of students' names. Access to the data by any other person; both in soft and hard copies were not allowed. In presenting the findings and discussing the results, school centre numbers will be used in place of school names. This level of confidentiality is regarded as adequate to ensure participants' human rights.

Chapter 4

Data Analysis and Interpretation

The study was aimed at determining the validity of PSLE grades in predicting JCE performance in mathematics for the years 2012 and 2013. This chapter is mainly focused at analysing research data and interpreting the results. For each of the two years, the Pearson correlation coefficient and regression analysis were used on the entire samples. The entire six hypotheses were tested in the null form each at the .05 alpha levels. The statistical null hypotheses to be tested are as follows:

- The students' PSLE 2009 mathematics grades are not significantly valid at predicting performance in JCE 2012 mathematics final examinations.
- The students' PSLE 2010 mathematics grades are not significantly valid at predicting performance in JCE 2013 mathematics final examinations.
- The students' grades in mathematics in PSLE 2009 are not significantly valid at predicting performance in JCE 2012 mathematics examinations among females and males.
- The students' grades in mathematics in PSLE 2010 are not significantly valid at predicting performance in JCE 2013 mathematics examinations among females and males.
- The students' grades in PSLE 2009 mathematics are not significantly valid at predicting performance in JCE 2012 mathematics final examinations among urban and rural schools.
- The students' grades in PSLE 2010 mathematics are not significantly valid at predicting performance in JCE 2013 mathematics final examinations among urban and rural schools.

Hypothesis Testing

Hypothesis 1

In the null the hypothesis states that students' PSLE 2009 mathematics grades are not significantly valid at predicting performance in JCE 2012 mathematics final examinations.

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In testing this hypothesis, regression analysis was used. JCE 2012 was the dependent variable and PSLE 2009 was the predictor variable in the regression analysis. (see Tables 5).

Table 5:

Regression Analysis for Predicting JCE 2012 Mathematics Performance Using PSLE 2009 Mathematics Grades

Model		Sum of Squares	df	Mean Square	R^2	F	Sig
	Regression	5271.33	1	5271.33	.53	8096.13	.000[b]
	Residual	4727.59	7261	.65			
	Total	9998.92	7162				

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std error	Beta		
	(Constant)	-.48	.041		-11.50	.000
	PSLE 2009	.88	.73	.73	89.98	.000

The regression analysis presented in Table 5 shows a highly significant regression effect of $F_{(1, 7261)} = 8096.13$ which was much greater than the critical F-value of 3.84 for 1 and 7261 degrees of freedom at .05 significance level. The analysis gave the standardized predictive validity index of .73 which is significant well beyond the .05 alpha levels. These results led to the rejection of the null hypothesis. That is to say, students' PSLE mathematics scores significantly predict their JCE mathematics score. The regression coefficient indicated that each one point of an increase in PSLE 2009 mathematics grade resulted in an increase in JCE mathematics score of .88 and a further reduction of .48 as shown by the constant. This shows clearly that the students' JCE predicted mathematics scores are about one grade point lower than their PSLE mathematics grade.

The results of the analysis produced the unstandardized (Formula 1) and standardized (Formula 2) regression equations.

$$JCE_{2012} = .88 \times PSLE_{2009} - .48 \quad (1)$$

$$Z_{JCE(2012)} = .73 \times Z_{PSLE2009} \quad (2)$$

The analysis showed R squared to be .53 indicating that 53% of the variance in JCE 2012 mathematics scores is accounted for by PSLE 2009 mathematics scores.

Hypothesis 2

In the null form, this hypothesis states that the students' PSLE 2010 mathematics grades are not significantly valid at predicting performance in JCE 2013 mathematics final examinations.

In testing this hypothesis, regression analysis was used (see Table 6). JCE 2013 was the dependent variable, while PSLE 2010 was the predictor variable. The results of this regression analysis shows that there is a significant regression effect of $F_{(1, 8033)} = 9140.45$ and standardized predictive validity index of .73 which is significant beyond the set .05 alpha level . Based on these results, the null hypothesis was rejected. This is to say that students'

Table 6:

Regression Analysis for Predicting JCE 2013 Mathematics Performance Using PSLE 2010 Mathematics Grades

Model		Sum of Squares	df	Mean Square	R^2	F	Sig
	Regression	6549.33	1	6549.33	.53	9140.45	.000[b]
	Residual	5755.82	8033	.72			
	Total	12305.15	8034				

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig
		B	Std error	Beta		
	(Constant)	-1.04	.042		-25.08	.000
	PSLE 2010	.95	.010	.73	95.61	.000

PSLE mathematics results are significantly valid at predicting their JCE mathematics scores. The regression coefficient and constant indicates that each one point increase in PSLE 2010 mathematics score resulted in an increase of .95 in JCE 2013 mathematics scores and a subsequent reduction of 1.04 which means that the students' predicted JCE mathematics scores are about one grade point lower than their PSLE mathematics score. This analysis gave the prediction equation for unstandardized (Formula 3) and standardized (Formula 4) values of the variables involved.

$$JCE_{2013} = .95 \times PSLE_{2013} - 1.04 \quad (3)$$

$$ZJCE_{2013} = .73 \times ZPSLE_{2010} \quad (4)$$

The analysis further revealed R squared to be .53 indicating that about 53 % of the variance in JCE 2013 mathematics scores is explained by variation in PSLE 2010 scores.

Hypothesis 3 (a)

In the null form, this hypothesis states that the students' grades in mathematics in PSLE 2009 are not significantly valid at predicting performance in JCE 2012 mathematics examinations among females.

In testing this hypothesis, PSLE 2009 and JCE 2012 scores for female students were applied in a regression analysis (see Table 7).The results show that there is a significant regression effect of $F_{(1, 3517)} = 3768.38$ and standardized predictive validity index of .72 which is also significant given the .05 alpha level. These results led to the rejection of the null hypothesis. This means that PSLE mathematics scores significantly predict JCE mathematics scores for female students. The analysis gave the prediction equation for unstandardized (Formula 5) and standardized (Formula 6) values of the variables involved.

$$JCE_{2012} = .87 \times PSLE_{2009} - .44 \quad (5)$$

$$Z_{JCE2012} = .72 \times Z_{PSLE\ 2009} \quad (6)$$

The regression coefficient and constant indicate that each one point increase in PSLE 2009 mathematics score result in a .87 increase in JCE predicted mathematics score and a further reduction of .44. This means that the female students' predicted JCE mathematics scores are one grade point lower than their PSLE scores. The results also revealed R squared of .53, which shows that 53% of variation in JCE mathematics scores for females is explained by variation in PSLE scores.

Table 7:

Regression Analysis for Predicting JCE 2012 Mathematics Performance Using PSLE 2009 Mathematics Grades for Females

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	2351.39	1	2351.39	.53	3768.38	.000[b]
	Residual	2194.52	3517	.62			
	Total	4545.92	3518				

	Unstandardized Coefficients		Standardized Coefficients	T	Sig
	B	Std error	Beta		
(Constant)	-.44	.062		-8.00	.000
PSLE 2009	.87	.014	.72	61.39	.000

Hypothesis 3 (b)

This hypothesis in the null form states that students' grades in mathematics in PSLE 2009 are not significantly valid at predicting performance in JCE 2012 mathematics examinations among males.

In testing this hypothesis, PSLE 2009 and JCE 2012 scores for male students were applied in a regression (see Table 8). The results show that there is a significant regression effect of F ($_{1,}$

$_{3540}$) = 4217.11 and standardized predictive validity index of .73 which is also significant given the .05 alpha level. These results led to the rejection of the null hypothesis, which means that PSLE mathematics scores successfully predicts JCE mathematics scores among the male students. The regression coefficient and the constant indicate that the one point increase in PSLE mathematics score results in a .89 increase in JCE mathematics score and a .52 drop, which means the male students predicted JCE mathematics scores are one grade point lower than their PSLE scores. The analysis gave the prediction equation for unstandardized (Formula 7) and standardized (Formula 8) values of the variables involved.

$$JCE_{2012} = .89 \times PSLE_{2009} - .52 \quad (7)$$

$$Z_{JCE2012} = .73 \times Z_{PSLE2009} \quad (8)$$

The analysis gave R squared of .53, which means 53 % of variance in JCE mathematics scores is accounted for by PSLE scores among the male students.

Table 8:

Regression Analysis for Predicting JCE 2012 Mathematics Performance Using PSLE 2009 Mathematics Grades for Males

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	2851.15	1	2851.15	.53	4217.11	.000[b]
	Residual	2528.58	3740	.66			
	Total	5379.73	3741				
		Unstandardized Coefficients		Standardized Coefficients		T	Sig
		B	Std error	Beta			
	(Constant)	-.52	.057			-9.24	.000
	PSLE	.89	.014	.73		64.94	.000

Hypothesis 4 (a)

The students' grades in mathematics in PSLE 2010 are not significantly valid at predicting performance JCE 2013 mathematics examinations among females.

In testing this hypothesis, PSLE 2010 and JCE 2013 scores for female students were applied in a regression (see Table 9). The results show that there is a significant regression effect of $F_{(1, 3971)} = 4253.47$ and standardized predictive validity index of .72 which is also significant given the .05 alpha level. The results led to the rejection of the null hypothesis. This is to say, the students' PSLE mathematics grades are good predictors of JCE mathematics scores. The regression coefficient and the constant shows that for one point increase in PSLE 2010 there is an increase of .93 and a subsequent reduction of .90 in the predicted score. This means the female students' JCE mathematics scores are one grade point lower than their PSLE mathematics scores. The analysis gave the prediction equation for unstandardized (Formula 7) and standardized (Formula 8) values of the variables involved.

$$JCE_{2013} = .93 \times PSLE_{2010} - .90 \quad (7)$$

$$Z_{JCE2013} = .72 \times Z_{PSLE2010} \quad (8)$$

The analysis gave R squared of .52, which means 52 % of variance in JCE mathematics scores is accounted for by PSLE scores among the female students.

Table 9:

Regression Analysis for Predicting JCE 2013 Mathematics Performance Using PSLE 2010 Mathematics Grades for Females

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	3023.30	1	3023.30	.52	4253.47	.000[b]
	Residual	2822.52	3971	.71			
	Total	5845.89	3972				
		Unstandardized Coefficients		Standardized Coefficients		T	Sig
		B	Std error	Beta			
	(Constant)	-.90	.060			-14.86	.000
	PSLE 2009	.93	.014	.72		65.22	.000

Hypothesis 4 (b)

The hypothesis in the null form states that the students' grades in mathematics in PSLE 2010 are not significantly valid at predicting performance in JCE 2013 mathematics examinations among males.

In testing this hypothesis, PSLE 2010 and JCE 2013 scores for male students were applied in a regression (see Table 10). The results show that there is a significant regression effect of $F_{(1, 4058)} = 4812.92$ and standardized predictive validity index of .74 which is also significant given the .05 alpha level. This result means that PSLE mathematics scores are a good predictor of JCE mathematics scores; therefore the null hypothesis was rejected. The regression coefficient of .96 and constant of 1.15 means that one point increase in PSLE 2010 mathematics scores result in an increase of .96 and a further reduction of 1.15 on the predicted JCE mathematics scores. This implies that the male students' predicted maths

scores are one grade point lower than their PSLE scores. The analysis gave the prediction equation for unstandardized (Formula 9) and standardized (Formula 10) values of the variables involved.

$$JCE_{2013} = .96 \times PSLE_{2010} - .1.15 \quad (9)$$

$$Z_{JCE2013} = .74 \times Z_{PSLE2010} \quad (10)$$

The analysis gave R squared of .54, which means 54 % of variance in JCE mathematics scores is accounted for by PSLE scores among the male students.

Table 10:

Regression Analysis for Predicting JCE 2013 Mathematics Performance Using PSLE 2010 Mathematics Grades for Males

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	3448.16	1	3448.16	.54	4812.92	.000[b]
	Residual	2907.30	4058	.72			
	Total	6355.46	4059				
		Unstandardized Coefficients		Standardized Coefficients		T	Sig
		B	Std error	Beta			
	(Constant)	-1.150	.057			-20.06	.000
	PSLE 2009	.96	.014	.74		69.38	.000

Hypothesis 5 (a)

In the null form, the hypothesis states that the students' grades in mathematics in PSLE 2009 are not significantly valid at predicting performance in JCE 2012 mathematics examinations among urban schools.

In testing this hypothesis, PSLE 2009 and JCE 2012 scores for urban schools were applied in a regression (see Table11). The results show that there is a significant regression effect of $F_{(1, 3920)} = 4285.03$ and standardized predictive validity index of .72 which is also significant given the .05 alpha level. These results imply that PSLE mathematics scores are a good predictor of JCE mathematics score in urban schools, hence rejection of the null hypothesis. The regression coefficient and constant shows that JCE mathematics predicted scores are the product of the students' PSLE scores and .88 and a further drop of .39 which means the predicted scores are one grade point lower than the PSLE scores in urban schools. The analysis gave the prediction equation for unstandardized (Formula 11) and standardized (Formula 12) values of the variables involved.

$$JCE_{2012} = .88 \times PSLE_{2009} - .39 \quad (11)$$

$$Z_{JCE2012} = .72 \times Z_{PSLE2009} \quad (12)$$

The analysis revealed R squared of .54, which means 54 % of variance in JCE mathematics scores is accounted for by PSLE scores for urban schools.

Table 11

Regression Analysis for Predicting JCE 2012 Mathematics Performance Using PSLE 2009 Mathematics Grades for Urban Schools

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	2905.91	1	2905.91	.52	4285.03	.000[b]
	Residual	2658.37	3920	.68			
	Total	5564.28	3921				
		Unstandardized Coefficients		Standardized Coefficients		T	Sig
		B	Std error	Beta			
	(Constant)	-.39	.058			-6.70	.000
	PSLE 2009	.88	.013	.72		65.46	.000

Hypothesis 5(b)

The null hypothesis states that students' grades in mathematics in PSLE 2009 are not significantly valid at predicting performance in JCE 2012 mathematics examinations among rural schools.

In testing this hypothesis, PSLE 2009 and JCE 2012 scores for rural schools were applied in a regression (see Table 12). The results show that there is a significant regression effect of $F_{(1, 3339)} = 3665.24$ and standardized predictive validity index of .72 which is also significant given the .05 alpha level. These results show that PSLE mathematics scores successfully predicts JCE mathematics scores in rural schools which led to the rejection of the null hypothesis. The regression coefficient and the constant shows that the predicted mathematics score is the product of students' PSLE mathematics scores and .85 and a subsequent drop of .48 in rural schools. This implies that the JCE predicted mathematics scores are one point lower than the PSLE scores. The analysis gave the prediction equation

for unstandardized (Formula 13) and standardized (Formula 14) values of the variables involved.

$$JCE_{2012} = .85 \times PSLE_{2009} - .48 \quad (13)$$

$$Z_{JCE2012} = .72 \times Z_{PSLE2009} \quad (14)$$

The analysis gave R squared of .52, which means 52 % of variance in JCE mathematics scores is accounted for by PSLE scores among the rural schools.

Table 12:

Regression Analysis for Predicting 2012 JCE Mathematics Performance Using 2009 PSLE Mathematics Grades for Rural Schools

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	2187.62	1	2187.62	.52	3665.24	.000[b]
	Residual	1992.90	3339	.60			
	Total	4180.52	3340				
		Unstandardized Coefficients		Standardized Coefficients		T	Sig
		B	Std error	Beta			
	(Constant)	-.48	.058			-8.27	.000
	PSLE 2009	.85	.014	.72		60.54	.000

Hypothesis 6 (a)

In the null form, the hypothesis states that students' grades in mathematics in PSLE 2010 are not significantly valid at predicting performance in JCE 2013 mathematics examinations among urban schools.

In testing this hypothesis, PSLE 2010 and JCE 2013 scores for urban schools were applied in a regression (see Table 13). The results show that there is a significant regression effect of

$F_{(1, 3907)}$ = 4641.58 and standardized predictive validity index of .74 which is also significant given the .05 alpha level. This gave the prediction equation for unstandardized (Formula 15) and standardized (Formula 16) values of the variables involved.

$$JCE_{2013} = .96 \times PSLE_{2010} - 1.03 \quad (15)$$

$$Z_{JCE2013} = .74 \times Z_{PSLE2010} \quad (16)$$

These results show that PSLE mathematics scores are a good predictor of JCE mathematics score in urban schools. The regression coefficient of .96 and constant of -1.03 indicate that the predicted JCE mathematics scores is calculated by finding the product of

Table 13:

Regression Analysis for Predicting JCE 2013 Mathematics Performance Using PSLE 2010 Mathematics Grades for Urban Schools

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	3395.06	1	3395.06	.54	4641.58	.000[b]
	Residual	2857.75	3907	.73			
	Total	6252.81	3908				
		Unstandardized Coefficients		Standardized Coefficients		T	Sig
		B	Std error	Beta			
	(Constant)	-1.03	.061			-16.91	.000
	PSLE 2009	.96	.014	.74		68.13	.000

PSLE score and .96 and further subtracting 1.03. This shows clearly that the predicted JCE mathematics scores of urban schools are one point low than the PSLE score. The analysis revealed R squared of .54, which means 54 % of variance in JCE mathematics scores is accounted for by PSLE scores for urban schools.

Hypothesis 6 (b)

This hypothesis in the null states that the students' grades in mathematics in PSLE 2010 are not significantly valid at predicting performance in JCE 2013 mathematics examinations among rural schools.

In testing this hypothesis, PSLE 2010 and JCE 2013 scores for rural schools were applied in a regression and Pearson correlation analyses and (see Table 14). The results show that there is a significant regression effect of $F_{(1, 4124)} = 4200.47$ and standardized predictive validity index of .71 which is also significant given the .05 alpha level. These results show that PSLE mathematics scores are a good predictor of JCE mathematics scores and therefore the null hypothesis was rejected. The regression coefficient of .93 and constant of -1.00 means that the JCE predicted mathematics scores in rural schools are equal to the product of PSLE scores and .93 and a further drop of 1.00.

Table 14:

Analysis for Predicting JCE 2013 Mathematics Performance Using PSLE 2010 Mathematics Grades for Rural Schools

Model		Sum of Squares	Df	Mean Square	R^2	F	Sig
	Regression	2934.93	1	2934.93	.51	4200.47	.000[b]
	Residual	2881.49	4124	.70			
	Total	5816.42	4125				
		Unstandardized Coefficients		Standardized Coefficients		T	Sig
		B	Std error	Beta			
	(Constant)	-1.00	.058			-17.26	.000
	PSLE 2009	.93	.014	.71		64.81	.000

This shows that the predicted scores will be one grade point lower than the PSLE scores. This analysis gave the prediction equation for unstandardized (Formula 17) and standardized (Formula 18) values of the variables involved.

$$JCE_{2013} = .93 \times PSLE2010 - 1.00 \quad (17)$$

$$Z_{JCE2013} = .71 \times Z_{PSLE2010} \quad (18)$$

The analysis revealed R squared of .51, which means 51 % of variance in JCE mathematics scores is accounted for by PSLE scores for urban schools.

Table 15:

Summary of Equations for Gender- and Location-Based Prediction of JCE 2012 & 2013 Mathematics Examinations Using PSLE 2009 & 2010 Mathematics Score

Group	2009-PSLE Predicting 2012-JCE	2010-PSLE Predicting 2013- JCE
All Students	$JCE_{2012} = .879\ PSLE_{2009} - .476$	$JCE_{2013} = .951 PSLE_{2010} - 1.043$
Male	$JCE_{2012} = .894 PSLE_{2009} - .524$	$JCE_{2013} = .964 PSLE_{2010} - 1.150$
Female	$JCE_{2012} = .866 PSLE_{2009} - .437$	$JCE_{2013} = .929 PSLE_{2010} - .898$
Urban	$JCE_{2012} = .881 PSLE_{2009} - .390$	$JCE_{2013} = .958 PSLE_{2010} - 1.028$
Rural	$JCE_{2012} = .853 PSLE_{2009} - .481$	$JCE_{2013} = .930\ PSLE_{2010} - 1.001$

Summary of the Findings

The results from testing Hypothesis 1 and 2 demonstrated that both PSLE 2009 and PSLE 2010 examined in this study predict significantly the performance in JCE mathematics examination. The study shows clearly that PSLE mathematics results are valid in predicting students' performance in JCE mathematics examinations. In both years, the results revealed a highly significant regression effect. The significant results obtained lead to the rejection of the null hypotheses tested. The prediction equations for both hypothesis shows that the

students' JCE predicted mathematics scores would be one point lower than the PSLE mathematics score. The findings of Hypotheses 3 and 4 for both 2012 and 2013 proved that PSLE mathematics results are good predictors of JCE mathematics results in both female and male students. For both male and female students a high regression effect was obtained in testing the hypotheses. The prediction equations for both hypotheses show that the students predicted JCE mathematics scores are one point below the PSLE mathematics score.

The results from Hypotheses 5 and 6 showed that PSLE mathematics results are good predictor of JCE mathematics performance for both 2012 and 2013 in both urban and rural schools. A high regression effect resulted in testing the two hypotheses. Since all the results obtained are significant, all the null hypotheses were rejected. The prediction equations for the hypotheses shows that the students' JCE predicted mathematics scores are one grade point below the PSLE scores. This shows that most of the students at JCE level obtain grades that are a unit below what they obtained at PSLE level.

Chapter 5

Discussion, Summary, Conclusions and Recommendations

Introduction

The aim of this study was to examine the validity of performance in 2009 and 2010 PSLE mathematics in predicting performance in 2012 and 2013 JCE mathematics examinations. This chapter discusses research findings and further brings forth the summary, implication of the study findings, conclusion and the recommendations.

Summary of the Study

The study was conducted on sample of 7263 and 8035 candidates who sat for mathematics JCE examinations in 2012 and 2013 respectively around Botswana. The main purpose of this study was to determine the validity of PSLE mathematics grades in predicting students' performance in JCE mathematics. The study was designed to answer the following questions:

- To what extent do students' grades in 2009 PSLE mathematics valid at predicting performance in 2012 JCE mathematics examinations?
- To what extent do students' grades in 2010 PSLE mathematics valid at predicting performance in 2013 JCE mathematics examinations?
- To what extent do students' 2009 PSLE mathematics grades valid at predicting performance in 2012 JCE mathematics examinations among males and females?
- To what extent do students' 2010 PSLE mathematics grades valid at predicting performance in 2013 JCE mathematics examinations among males and females?
- To what extent do students' grades in 2009 PSLE mathematics valid at predicting performance in 2012 JCE mathematics examinations among urban and rural schools?

- To what extent do students' grades in 2010 PSLE mathematics valid at predicting performance in 2013 JCE mathematics examinations among urban and rural schools?

The computer-assisted data analyses using statistical package for social sciences (SPSS) were carried out and the results presented in Chapter 4. The discussion of the results is presented according to the research questions.

Discussion of the Findings

Validity of PSLE Mathematics Scores in Predicting Performance in JCE Mathematics

The findings of the study confirmed the validity of PSLE mathematics scores in predicting JCE mathematics performance. In both 2012 and 2013 JCE mathematics results, fifty three percent of variance is explained by the variation in 2009 and 2010 PSLE grades. This is to say that factors other than performance in PSLE are responsible for the 47% of the performance in JCE. These factors may include: absenteeism from school, discipline problems, students socio economic background and lack of resources among others. PSLE mathematical scores were found to be highly influential variables in predicting JCE mathematics scores. The contributing factor to this effect might be the fact that JCE mathematics syllabus repeats the same topics that were covered at primary schools but the level of difficulty of the content increase as the students' progress across the levels of JCE. The findings of the study on PSLE scores are supported by the predictive validity evidence concept, which indicates that if the correlation between the test and the criterion is higher the more confident we are about the worth of the test. Since the predictive validity index between PSLE 2009 and JCE 2012 scores and PSLE 2010 and JCE 2013 scores (.73) are high, we are confident about the worth of PSLE mathematics scores in predicting JCE mathematics scores. A similar percentage (53%) that accounted for variance in JCE mathematics scores were observed in the two years means that there is consistency in the validity levels of PSLE scores in predicting JCE mathematics scores. As a result of that, we can say the findings of

this study proved the degree to which PSLE actually measures what it claims to measure and how well it serves on its intended purposes, which is prediction of JCE performance (Herman & Choi, 2012). Even though both the regression effect and the Pearson correlation are significantly high, the prediction equations found in the two years reveal that the students' predicted JCE mathematics scores would be about one point of a grade lower than their PSLE mathematics. This is to say, JCE mathematics teachers generally do not add value to the students' performance and this may be caused by the fact that the JCE mathematics syllabus is congested and therefore teachers do not teach students for understanding but rather to finish the packed syllabus within a short space of time. The findings concur with those of Jarego (2013) who found that the students performance in Kenya Certificate of Primary Education positively correlates with the students' performance in Kenya Certificate of Secondary Education, thus students who performed well at Kenya Certificate of Primary Education are likely to do well at Kenya Certificate of Secondary Education. However, these findings were contrary to Faleye and Afolabi (2005) whose study indicated that Osun State JSCE is a poor predictor of students' performance in SSCE. The findings of the present study also disagree with the findings of Adeyemi (2008), who reported that there was no significant relationship between the students' performance in Junior Secondary Certificate mathematics and students' performance in Senior Secondary Certificate mathematics examinations in Ondo State, Nigeria.

Gender and Validity of PSLE Mathematics Scores in Predicting JCE Performance

An equal percentage of variance (fifty two) in JCE mathematics results is explained by variance in PSLE scores for 2009 and 2010 among the female students. About the same values were observed in male students; fifty three percent of variance in JCE was accounted for by variation in PSLE 2009 and fifty four percent variance in 2013 JCE mathematics results was explained by variation in PSLE 2010.This is to say, there is no significant

difference in validity of PSLE mathematics scores in predicting performance in female and male students. Although the previous years' JCE results shown that female students perform better than their male counterpart in mathematics, the present study revealed a significant regression effect for predicting performance for JCE mathematics for both genders. Amongst all other factors that can predict students' JCE mathematics performance, PSLE mathematics scores account for a larger percentage for both females and males. This might be due to the fact that both females and males have the same perceptions towards mathematics nowadays. This is to say that, there are some female and male students who like mathematics and perceive it like any other subject. On the other hand, there are some female and male students who are negative towards mathematics and perceive it as a difficult subject. The numbers for such students are somehow balancing across the schools, hence similar values for variance accounted for PSLE scores for females and males. Unlike early on, boys no longer dominate in mathematics lessons. There is generally gender balance in class participation and performance in mathematics. Male students unlike female students indulge more in indiscipline activities and disregard their academics. And as such, their capabilities in mathematics decline and consequently counter balanced with the females. The findings of the present study agreed with the results of Njakululu (2012) who reported that in mathematics the relationship indicated that Kenya Certificate of Primary Education is a valid predictor of success of girls in mathematics in secondary school. The results of this study are also in consonance with the findings of Ramatlala (2009) who reported that there is a high and significant variance in BGCSE physical education scores that is explained by variation in coursework grades in male students. The findings of this study negated the findings of Isa and Balarabe cited in Edokpayi (2011) who reported that female students exhibit poor attitudes towards the study of mathematics, and this is portrayed in their achievement in this subject in public examinations.

Location and Validity of PSLE Mathematics Scores in Predicting JCE Performance

The results shown that fifty two percent of variance in 2012 JCE mathematics scores is accounted for by variance in 2009 PSLE scores and fifty four percent of variance in 2013 JCE mathematics scores is explained by variance in PSLE 2010 in urban schools. On the other hand, in rural school fifty two percent of variance in JCE mathematics scores was accounted for by 2009 PSLE mathematics scores and in 2013, fifty percent of variance in JCE mathematics scores was explained by variance in PSLE mathematics scores. The trend in rural schools is somehow similar to that of urban schools. Kubiszyn and Borich (2013) state that for test to be good it ought to have sufficient confirmation for its validity for the purpose it is used for and the persons with whom it is used. PSLE in this study was proved good as its validity in predicting performance in JCE was verified for students in both rural and urban schools. Since about the same values were obtained for both urban and rural schools this shows that PSLE scores function equally for the purpose it is used for and the students with whom it is used, regardless of their geographical location. Surprisingly, the prediction equations for both urban and rural schools reveal that the students' predicted JCE mathematics grades are one point of a grade lower than their PSLE grade. The students in urban schools have a better chance of performing better than students in rural schools because they are exposed to lot resources that can help them make sense of mathematics. For instance, there is a topic in JCE syllabus on banking, for rural students the discussions on services offered at the banks will be theoretical because they are not exposed to what happens in banks and probably difficult for them to understand. On the other hand, when the topic is taught in urban schools the students easily make sense of what is being discussed because they have exposure of what is offered at the banks. In this instance, one would expect urban students to maintain their PSLE grades or obtain higher grades at JCE than rural students.

However, this shows that both PSLE and JCE examinations are valid, regardless of the location of the students.

These findings of this study negate those of Sunday and Olantunde (2011) who reported that there is a significant difference between students' academic achievement of rural and urban secondary schools in senior school certificate examination. The findings were in consonance with those of Boikanyo (2011) who found that performance in mathematics and science in JCE is a good predictor of performance in the BGCSE mathematics in both rural and urban schools. This might be due to the fact that there is equity in distribution of resources among schools. On the other hand, the insignificant difference observed between urban schools and rural schools might be as a result of increased levels of indiscipline in urban schools which in one way or the other affect students' academic performance.

For this study, all the hypotheses tested yielded a high regression effect; therefore we are convinced that PSLE mathematics scores are good predictors of JCE mathematics scores. Validity of assessment results is concerned with soundness of interpretations and uses of students' assessment results. The findings of this study ascertained that the uses of PSLE mathematics scores in predicting JCE mathematics are valid and appropriate.

Summary of the Study

Most of the students obtain better mathematics grades at PSLE level and fail to maintain them or obtain higher grades at JCE level. The purpose of the study was therefore, to determine the validity of PSLE mathematics scores in predicting performance in JCE mathematics for two years, 2012 and 2013. The study further investigated whether gender and school location had any influence in the predictive validity of performance in mathematics over the two years. Data for 2009 and 2010 PSLE and 2012 and 2013 JCE mathematics scores were collected from Botswana Examination Council. The data was

analyzed by finding the regression coefficient. The findings were that PSLE mathematics scores significantly predicted performance in JCE mathematics. The results for both the gender and location were significant regression. These results signify necessity to consider several variables in future in order to come up with instructive and best predictive models.

Conclusions

Based on the findings of the study, a conclusion can be made that PSLE mathematics scores are a good predictors of performance in JCE mathematics in Botswana. The findings of this study reveal clearly the relationship between PSLE mathematics results and JCE mathematics scores. A high percentage of the variance, thus fifty percent and more in JCE mathematics scores was explained by variation in PSLE mathematics scores over the two years. The findings also revealed that PSLE mathematics scores significantly predict performance in JCE mathematics among male and female students. There was no significant gender difference on the ability of PSLE mathematics in predicting performance in JCE mathematics examinations. For the female students, in both 2012 and 2013, fifty two percent of variance in JCE mathematics scores was explained by variations in PSLE mathematics scores. For male students, fifty three and fifty four percent in 2012 and 2013 JCE mathematics scores respectively was accounted for by variations in 2009 and 2010 PSLE mathematics scores. The findings also shown that PSLE mathematics scores are good predictors of performance in JCE mathematics examinations among urban and rural schools. However, the prediction equations revealed that that for all the hypotheses tested, the students' predicted JCE mathematics scores are generally one grade point below their PSLE grades.

Implications of the Findings

The findings from this study have implications for the Ministry of Education and Skills Development, Botswana Examination Council, Curriculum Development and Evaluation Unit, teachers, parents and students. The study has evidently shown that despite the fact that PSLE mathematics scores successfully predict JCE mathematics scores; generally there is poor performance at both PSLE and JCE level. The following implications were drawn from the findings of the study:

- The Ministry of Education and Skills Development officials are not doing enough to ensure that teachers at both primary and junior secondary school levels use teaching strategies that will improve students' performance in mathematics. The students come from primary school with poor mathematics grades and obtain the same grades or drop to lower grades at JCE level, which means the junior secondary mathematics teachers are not adding any value to students' performance.
- The findings have shown that PSLE mathematics scores are a good predictor of JCE mathematics scores, which means both PSLE and JCE are valid and as such the Botswana Examination Council should keep on working hard in ensuring validity of their examinations.
- The Curriculum Development and Evaluation Unit is responsible for designing the curriculums that are tested at PSLE and JCE levels; the findings have shown that PSLE mathematics scores predicts well JCE mathematics scores and even though this is the case, generally there is poor performance across the two levels. The implication may be that the curriculum has a lot to be covered within a short period of time or the content taught is rather too high for the students' cognitive levels.
- Teachers at primary schools do not produce good results in PSLE mathematics examination and the same poor results predict well JCE mathematics result. Teachers

at both levels are not doing much to improve students' performance in mathematics. There is no value addition at JCE level. Junior secondary school teachers need to find a way of working together with primary school teachers to assist them in handling some topics. Teachers as individuals need to do a lot of research to find teaching methods that can help them add value to the performance of their students.

- Parents do not find ways of improving their children's grades at JCE level. The findings of the study revealed that PSLE scores successfully predicts JCE mathematics scores which means most of the students at JCE level obtain the same grades they obtained at PSLE level. If the child did not do well in mathematics at PSLE level, the parents should find ways of assisting the child that can ultimately yield good results.
- The students who passed PSLE mathematics examinations tend to pass JCE mathematics examination and those who failed PSLE mathematics examinations tend to fail JCE mathematics examinations. Mathematics is a core subject at JCE level, therefore the students need to change their mind set towards mathematics and find ways of improving their performance in the subject so that it does affect their overall performance in JCE examinations.

Recommendations

The recommendations are made for various stake holders based on the findings and conclusions of the study. It is hoped that the recommendations will serve to assist the Ministry of Education and Skills Development, Botswana Examination Council, Curriculum Development and Evaluation Unit, teacher training institutions, Teacher Training and Development Department, teachers and parents to accomplish their responsibilities diligently in improving students' performance in mathematics.

- The MoE&SD should ensure that teachers and schools at large account for poor results in situations where students JCE mathematics grades are drastically lower compared to their PSLE mathematics grades. Supervision and monitoring of such schools should then be done by subject education officers to make sure that teachers operations in classrooms yield good results. The ministry officials should also ensure that resources, proper training and mentoring are availed to the concerned schools to enable the teachers to perform.
- Botswana Examination Council should prepare comprehensive reports annually for schools comparing students' PSLE and JCE mathematics grades. The reports will enable the schools to make self evaluations and come up will proper strategies.
- The study yielded some JCE mathematics performance prediction equations which the Curriculum, Development and Evaluation unit can use to verify how the students generally perform in JCE mathematics curriculum and therefore see if there is need for changes or not.
- The teacher training institutions for both primary and junior secondary should equip pre-service mathematics teachers with teaching strategies that will foster an in-depth understanding of concepts to the learners to improve mathematics performance in both levels.
- The Teacher Training and Development department should equip in-service mathematics teachers with teaching strategies that can help students perform well in both PSLE and JCE levels. The study gave the prediction equations that the department should use on students' PSLE mathematics grades and a get a clear picture of how students perform at JCE level and therefore intervenes to help the situation.
- The teachers can use the JCE mathematics prediction equations on their students' PSLE grades to predict how they will perform at JCE level. The forecasted grades will

then help teachers come up with strategies of assisting the students to score higher than the predicted scores.

Recommendations for Further Research

The study used only one variable, PSLE grades, as a predictor of performance in mathematics at JCE level. The findings showed that this variable account for about fifty percent of variance, which means there are other factors that account for the other fifty percent. It is recommended based on the findings that further research that covers other variables be carried out. Poor performance in mathematics is a concern in Botswana, so a study involving several variables could bring about best predictive equations which can therefore be used by relevant stakeholders to improve the current situation.

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