Factors that cause poor performance in mathematics at National School Secondary Certificate level compared to Junior Secondary Certificate level in four selected schools in the two Kavango Educational regions

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Abstract

This paper reports on factors that cause poor performance in Mathematics at the National School Secondary Certificate (NSSC) level compared to Junior Secondary Certificate (JSC) level. A total of 200 learners in Grade 10 (2011) and 170 Grade 12 (2013) were involved in the study. These learners did Mathematics at the same school for a period of three years (2011-2013). This study employed document analysis, a technique used to gather information by reviewing and analysed documents. In this study the following documents were reviewed and analysed: The 2011 Grade 10 November examination results, and the 2013 Grade 12 November examination results, respectively. The findings of this study revealed that 2011 Grade 10 learners who obtained E-U symbols did not perform well in the Grade 12 Mathematics examinations. These findings were of utmost importance to the curriculum developers, the National Institute for Educational Development (NIED), senior education officers, the Ministry of Education, institutions of higher learning, and other stakeholders in Mathematics education.

Introduction

The teaching of Mathematics in Namibian schools has been a challenge since independence in 1990 as the learners' performance in Mathematics has been unimpressive, particularly at Upper Primary Phase (Ministry of Education, Florida State University & Harvard University, 1994; NIED, 2010 Iyambo, 2010; Sichombe, Tjipueja, & Nambira, 2013; Ilukena, 2008, cited in Ilukena, 2013; Southern African Consortium for the Monitoring of Education Quality [SACMEQ], 2004, cited in Ilukena, 2008). The high failure rates at Upper Primary Phase is evident in SACMEQ II (2004), and Namibia's Standardized Achievement Tests (SATs) results. The SACMEQ II research revealed that Namibian learners and their teachers performed poorly in Mathematics, as compared to the performance of learners and teachers at the same level in other Southern African countries. The Namibian SATs results show that Namibian learners are lagging behind in terms of numeracy levels. Furthermore, reasons for

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poor Mathematics performance is confirmed by the Department of National Examination and Assessment (DNEA, 2007), at Junior Secondary Certificate (JSC) in 2004 and 2006 respectively, showing that just a fraction of the learners scored very well (symbols A-C). In both years, the scores were more between D-U (U = Ungraded) symbols, with a significance tendency towards U-symbols. The poor performance in Mathematics among learners in Namibia continues to dominate public discussions, national media, and research (Clegg, 2007 & 2008; Nakale, 2013).

According to the majority of the teachers of Mathematics the high failure rate in Mathematics is also evident in other subjects, such as English and Science (Nakale, 2013). Some of the contributing factors are as follows: the English language proficiency of many teachers is considered poor or below the required standard of the Ministry of Education and Culture. This was due to the fact that English was adopted as medium of instruction in Namibian schools after independence. In most households in Namibia learners are not exposed to speaking English and the majority of the parents cannot speak, write, or read English. This hinders most of the parents from assisting their children with their school work because, generally, most parents knew only Afrikaans, which was used as medium of instruction before independence. This is coupled by the fact that it takes a long time to master a language, especially when exposure to it is limited (Raphael Mbala & Dr Hertha Pomuti, *Communication*, cited in Nakale, 2013). Another factor, according to the Permanent Secretary in the Ministry of Education, Alfred Ilukena (in Nakale, 2013), is that some teachers who did the Basic Education Teachers Diploma (BETD) course, were not trained to handle subjects at secondary level, making it difficult for them to be effective in teaching certain subjects in depth at Grades 11 and 12 levels.

Literature

Mathematics teachers whether at kindergarten, lower primary, upper primary or high school level have an individual goal of providing learners with knowledge and understanding of the Mathematics necessary to function in a world dependent upon the application of Mathematics. In support of this notion, the teachers need to use the models of teaching Mathematics so as to become mathematically proficient. The framework by Kilpatrick, Swafford, & Findell (2001, in Ilukena & Schäfer, 2013) encompasses the key features of knowing and doing mathematics. It also implies expertise in handling mathematical ideas, and only learners who are mathematically proficient would be able to use the five strands of mathematical proficiency in an integrated manner so that strands reinforce each other. According to Kilpatrick, *et al*. (2001, as cited in Ilukena & Schäfer, 2013, p. 23), the five strands are as follows:

- Conceptual understanding consists of those relationships constructed internally and connected to already existing ideas. It involves the understanding of mathematics ideas and procedures that include the knowledge of basic arithmetic facts, whereby learners should make use of conceptual understanding of mathematics when they identify and apply principles, know and apply facts and definitions, and compare and contrast related concepts. Knowledge learnt with understanding, provides a foundation for remembering or reconstructing mathematical facts and methods for solving new and unfamiliar problems, and for generating new knowledge.
- Procedural fluency is the skill of carrying out procedures flexibly, accurately, efficiently and appropriately. It includes, but is not limited to, algorithms (the step-by-step routines needed to perform arithmetic operations). Although the term "procedural" may imply arithmetic procedure to some, in the contents of research it refers to being fluent with the procedures. When learners learn procedures through understanding, they are more likely to remember the procedures and less likely to make common computational errors.
- Strategic competence, or problem solving, is the ability to formulate, represent and solve mathematical problems. It should be noted that problems are generally categorised into three groups: one-step problems, multi-step problems, and process problems. The solutions of such mathematical problems involve the integration of conceptual understanding and procedural knowledge. Thus learners need to have a broad range of strategies upon which they can apply in order to find the solution to a stated problem. Teachers should see to it that mathematics instructions provided to learners, include the teaching of many strategies to empower learners to be successful problem solvers. A concept or procedure in itself is not useful in problem solving unless one recognises when and where to use it, as well as when and where it does not apply.
- Adaptive reasoning: this requires learners to think logically, then write answers, explain and reflect where-after they have to justify their answers when an explanation is required.
- Productive disposition refers to the habitual inclination of persons to see mathematics as sensible, useful and worthwhile, coupled with a belief in their own diligence and efficacy.

These strands constitute the knowledge, skills, abilities and beliefs that all Mathematics learners should be able to master. They are intertwined with the development of proficiency in Mathematics. The first two strands are what most of the schools have observed and traditionally emphasised, whilst other schools primarily focused on procedural fluency. It should thus be emphasised that the five strands are interwoven and interdependent in the development of mathematical proficiency.

Some studies have, however, shown that differences reside in the opportunities available to learners, including opportunities to attend effective schools, opportunities afforded by social and economic factors of the home and school communities, and opportunities to get encouragement to continue the study of Mathematics. In addition, Tall, 1993 & 1996, and Kaput, 1991, as cited in Harries & Spooner, 2000, p. 29) discovered why so many more learners fail in Mathematics than any other subject. Those who fail are actually practising a more difficult kind of Mathematics than those who succeed. There is a tendency with low-attaining learners to use primitive mathematical objects and primary processes, for example, counting, to solve an addition problem, or repeated addition problem, in order to solve problems which could be more effectively solved using multiplication. It was further established that it is the proceptual divide that distinguishes those who progress well in Mathematics and those who struggle. Those who work procedurally are always carrying out far more time consuming work than those who can work proceptually.

Today, the currency of value in the job market constitutes more than computational competencies. Instead of simple computational knowledge, learners should be able to apply knowledge in order to solve problems, in order for them to compete in today's and tomorrow's economy. The learners need to be able to internalise the knowledge they acquired in Mathematics so that they will be able to learn and master higher basic competencies and integrate them into newly learnt concepts and skills in order for them to apply mathematical reasoning to problems. This became evident about learners in Namibia who were transferred without attaining the basic competencies for the grade failed at the exit points, specifically at Grades 10 and 12 levels (Sichombe, Nambira, Tjipueja, & Kapenda, 2011, p. 8). Learners who ignore Mathematics, or who do not take the subject seriously at primary level through secondary and tertiary levels, forfeit many future career opportunities. Recent studies have shown that Mathematics is a key subject in various fields of study, including physical sciences (e.g., Chemistry, Physics, Engineering), life and health sciences (e.g., Biology, Psychology, Pharmacy, Nursing, Optometry), social sciences (e.g., Anthropology, Communications, Economics, Linguistics, Education, Geography), technical sciences/IT (e.g., Computer Sciences, Networking, Software Development), business, commercial and actuarial sciences (used by insurances companies), and Medicine, Music, Law, Politics and Agriculture (see Gowers, 2011, and Writer, 2011, as cited in Ilukena, 2011). Therefore, the small number of Namibian learners pursuing their studies in Mathematics at institutions of higher learning, are potentially better equipped with the necessary skills at the lower phase, in order for them to pursue careers in Mathematics before the goals set in Vision 2030, are reached in Namibia.

Methodology

This research study was based on complementary approaches of qualitative and quantitative approaches and was conducted in two Kavango regions. The data was collected from a total of 200 learners in Grade 10 (2011) and 170 Grade 12 (2013). The study indicates that it is the same cohort of learners that were followed from Grade 10 in 2011 until 2013, when they wrote their Grade 12 November final examinations. This study studied documents recording the 2011 Grade 10 and 2013 Grade 12 final examinations results.

Results and Discussion

The results and discussion center around a total number of 200 learners who sat for the Junior Secondary Certificate (JSC) in 2011, and a total number of 170 of learners in Grade 12, who sat for the Namibia Senior Secondary Certificate (NSSC) in 2013 at the four selected schools in two Kavango Educational Regions at the times mentioned. These learners under discussion did mathematics at the same school for the period of three years.

The tables below, Tables 1 to 4, show the individual learner achievements per school, while Table 5 summarises the overall performances in Mathematics for a period of three (3) years.

Table 1: School X

	Grade 10 2011	Grade 12 2013		Grade 10 2011	Grade 12 2013
1	C	E	4	B	D
2	C	C	5	A	C
3	D	D	6	B	D

At School X, a total of six learners sat for examination both in JSC and NSSC levels. The six learners scored from A-D, achieving a 100% pass rate at the JSC level, while five out of the six learners scored C-D, achieving 83.3% pass rate at that level.

Table 2: School W

	Grade 10 2011	Grade 12 2013		Grade 10 2011	Grade 12 2013
1	B	D	11	B	E
2	B	B	12	C	D
3	B	D	13	E	E
4	B	D	14	C	E
5	C	D	15	C	D
6	D	E	16	C	F
7	C	D	17	C	E
8	B	C	18	C	E
9	B	D	19	B	E
10	B	D	20	B	C

At School W, a total of twenty learners sat for examinations at both JSC and NSSC levels. Nineteen out of twenty learners scored B-D, achieving a 95% pass rate at JSC level, while twelve out of twenty learners scored B-D, achieving a 60% pass rate at NSSC level.

Table 3: School Y

	Grade 10 2011	Grade 12 2013		Grade 10 2011	Grade 12 2013
1	F	G	5	D	D
2	G	U	6	G	G
3	G	G	7	D	D
4	F	E	8	E	F

At School Y, a total of eight learners sat for final examinations in both JSC and NSSC levels. As shown in Table 3, some learners scored the same symbols at both JSC and NSSC levels. One learner slightly improved from what was scored at JSC level to NSSC level, while three learners drastically dropped in their performance at NSSC level. This shows that the school's pass rate did not improve at all.

Table 4: School Z

	Grade 10 2011	Grade 12 2013		Grade 10 2011	Grade 12 2013
1	E	F	25	D	F
2	D	F	26	D	F
3	D	F	27	D	F
4	D	E	28	E	G
5	C	F	29	G	G
6	D	F	30	D	F
7	C	C	31	D	D
8	D	F	32	C	E
9	D	F	33	D	G
10	D	F	34	A	D
11	C	E	35	B	C
12	C	E	36	D	D
13	C	E	37	A	C
14	D	D	38	D	F
15	C	E	39	C	D
16	G	U	40	C	F
17	D	F	41	D	F
18	D	D	42	E	G
19	F	G	43	D	E
20	E	F	44	B	C
21	C	D	45	B	D
22	E	G	46	D	E
23	E	F	47	D	F
24	E	F	48	E	U

At School Z, a total of forty eight learners sat for final examinations at both JSC and NSSC levels. Thirty seven out of forty eight learners scored from A-D, achieving a 77% pass rate at JSC level, while only twelve out of forty eight scored from C-D, achieving a 25% pass rate at NSSC level.

Table 5: Performance of all the learners in Mathematics at the four selected schools in the 2011 and 2013 final year examinations

Level	**School**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**U**		**P**	**F**
JSC	X	1	2	2	1	-	-	-	-	6	6	-
NSSC	X	-	-	2	3	1	-	-	-	6	5	1
JSC	W	-	10	8	1	1	-	-	-	20	19	1
NSSC	W	-	1	2	9	7	1	-	-	20	12	8
JSC	Y	-	-	-	2	1	2	3	-	8	2	6
NSSC	Y	-	-	-	2	1	1	3	1	8	2	6
JSC	Z	2	3	10	22	8	1	2	-	48	37	11
NSSC	Z	-	-	4	8	8	19	7	2	48	12	36

Statistically, Table 5 shows that at JSC level a total of sixty four out of eighty two learners passed Mathematics and scored very well, indicated by their A-D symbols, while just a fraction of the total number of learners scored very poorly with E-G symbols. Unfortunately, one learner scored a U (Ungraded) symbol. This shows a pass rate of 78%, and a failure rate of 22% at JSC level. However, in comparison to the NSSC final examination results, only thirty one out of eighty two learners scored well with B-D symbols, whilst forty eight learners were clustered in the category E-G symbols, and three learners scored U (Ungraded) symbols. This shows a pass rate of 37.8%, and a failure rate of 62.2%. In terms of the percentage, the analysis shows that at JSC level, the pass rate is higher compared to the pass rate at NSSC level. This vast difference of past rate is probably due to the addition of continuous assessment marks (CA) to the JSC final examination mark while at NSSC level CA is not included in the final examination mark. At NSSC level, the failure rate is high because, apparently, learners did not master most of the basic mathematical competencies at JSC through Grades 11 to NSSC. Other reasons for poor performance in Mathematics, are that teachers of Mathematics skip topics that they are not comfortable with and, instead, focus on those they know, for example, the learners' inability to read; understand and interpret concepts of Mathematics; problems without relating to what they learnt in previous grades; and unawareness of teachers of the content and skills covered preceding grades. Thus, there is need for urgent intervention into the learners' poor performance in Mathematics. This can be done by addressing the following identified issues:

i) Close monitoring of low – achievers in each grade in mathematics

Mathematics teachers are encouraged to identify low – achievers and ensure that they (learners) participate in lessons and work on activities by incorporating the five strands for mathematics proficiency:

ii) Early Intervention and Prevention

Schools should focus on prevention and early intervention rather than waiting until signs of failure and frustration have set in (Sichombe, *et al*, 2011). An early intervention can be carried out in such a way that teachers offer remedial classes for the low achievers.

iii) The root cause of inability to read, understand and interpret the mathematical concepts by learners.

Mathematics teachers should be educated on how to handle learners with dyscalculia associated with dyslexia. The learning perceived as a specific learning difficulty for mathematics or more appropriately, not able to learn arithmetic facts, processing numerical magnitude and performing accurate and fluent calculation by learners. It is a conviction that teachers be empowered with expertise in remediation and special education. Learners need to read, write and practice mathematics. When they learn to read and write, they benefit from the language experience approaches such as Molteno's Break through to literacy (Macdonald & Burrow, 1999, p. 45). They need to attend to meaning of mathematical language and also to develop phonemic, phonemes and phonic awareness, the separate sounds of the language, and the relationship between sounds and spelling.

iv) Enhancing professional development for teachers

This will offer teachers the knowledge and skills they need to teach a wider range of subject content. They need an in-depth understanding of the three strands that's Subject Matter Knowledge (SMK), Pedagogical Knowledge (PK) and Pedagogical Content Knowledge (PCK) intertwined to provide learners with diverse approaches to learning and knowledge of multiple teaching strategies. Because mathematics at the rudimentary level has often been taught as a series of steps to follow in order to get the right answer. While they perform the operations and follow the procedures successfully, substantial evidence and classroom experiences indicate that an understanding of the reasoning for using these algorithms is alarmingly (Skemp, 1978, 1987, Tobin & Jukubowski, 1989, cited in Etchberger & Shaw, 1992; Ilukena & Schäfer, 2013). Teachers frequently encourage learners' algorithmic performance because it is easily observed and can be easily evaluated. However, when a learner is asked: "Why are you doing that?" they cannot give a reason other than, for example: "Because that's how it is done!", or "That is how the teacher said it should be done!" For the Namibian learners to become critical thinkers and problem solvers, mathematics teachers should move away from emphasising how to get to the answer and, instead, focus on why the procedure works that way to get to the answer. Furthermore, teachers should move from being dispensers of knowledge, and rather play the role of a facilitator as learners discover, gather, process and construct knowledge.

Conclusion and Recommendation

The findings from this research study concur with the findings from the literature and the national media on poor performance in Mathematics among learners. The poor performance at upper primary, JSC and NSSC, continue to dominate in public discussions, national media and research.

It is against this backdrop that we recommend following:

- All stakeholders should support compensatory teaching of mathematics during extended hours.
- Workshops on the mathematics curriculum should be held per circuit in the region whereby difficulty competences should be identified and discussed in detail.
- Institutions of higher learning should start offering a degree at NQF level 7 in mathematics content for pre-service teachers at JSC level.

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