Why student–teachers fail the basic mathematics module in first year of study at Rundu Campus of the University of Namibia?

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Introduction

The research paper reports on a study that examined the cause of failure among first year mathematics student - teachers registered for the Basic Mathematics module at the University of Namibia, Rundu Campus since the inception of the four year Bachelor of Education Honours (B. Ed. Hons) programme in 2011. Questionnaires were administered to 92 student teachers, but only 39 returned their questionnaires. The questionnaires sought the participants' perceptions and experiences with various aspects of the Basic Mathematics module. The grade 12 mathematics syllabi and the Basic Mathematics course outline were used to cross check the level of the content covered at secondary school and university.

The purpose of B. Ed (Hons) course was to address the perceived minimal mathematics content knowledge in the previous Basic Education Teachers Diploma (BETD) programme. The study further attempted to explore and identify areas that needed improvement in terms of the gap between high school mathematics and the mathematics offered by the University of Namibia in the first year, and how the situation could be addressed.

The context of the study

In recent years, there has been a noticeable increase in the diversity of background, talents and aspiration of students entering first year Basic Mathematics in the Department of Mathematics, Science and Sport Education (DMSSE) at Rundu Campus. This is probably due to the implementation of the new University of Namibia (UNAM) curriculum in mathematics since the merging of the UNAM and the four former Colleges of Education in 2010 that has been embraced with more subject content that was minimal in the BETD programme.

This research was trigged by the large number of B. Ed (Hons) students performing below 50 percent in the module, despite the introduction of two modes of study, a faster –and slow - streamed curricula of mathematics in 2011. The faster (normal) streamed are allowed to do the work in one – semester mode of study (first semester) while the slow – streamed covers the work in two semesters (the whole year). Second, the research investigated whether there was a gap between school mathematics and mathematics offered by the University of Namibia. And lastly it also explored the relevance of this course in terms of preparing teachers to teach mathematics at the Upper Primary School phase in Namibia. The basic mathematics modules cover a total of 6 topics, which are; sets, algebraic expressions, equations and inequalities, functions, trigonometry and sequence (see Table 5). Students often struggle with the following topics: sets, algebraic expressions (advanced factorisation, partial fractions, binomial theorem and expansion), trigonometry (trigonometric identities) and sequences (recursively defined sequences).

Significance of the study

Although the B. Ed (Hons) programme in Namibia with its emphasis on more subject content was rolled out in 2011, very little research has been conducted specifically on mathematics content knowledge at any of the four satellite campuses.

This research could thus benefit the four campuses, Hifikepunye Pohamba, Katima Mulilo, Khomasdal and Rundu. Furthermore it will be of benefit to the current B. Ed (Hons) mathematics student- teachers, learners, policy makers at National Institute for Educational Development (NIED), the Namibian public at

large and other institutions of higher learning in education in the country. Moreover, it will add value to the successful outcomes in mathematics teaching in Namibian schools as a result of the new UNAM curriculum that focuses on equipping mathematics student – teachers with the mastery of more mathematics content knowledge.

Questions of the study

The study focused specifically on the prospective students at Rundu Campus and asked the specific questions on the strength and weakness of the module.

1. How is the current upper primary B. Ed (Hons) student – teachers' high school mathematics performance like?
2. What is the current upper primary B. Ed, (Hons) mathematics student – teachers' pass rate in Basic Mathematics module?
3. How does the B. Ed (Hons) mathematics student – teachers' performance at UNAM relate to their high school performance in mathematics?

Literature review

Recent research has shown that many universities have altered their entry requirements in a bid to attract students, by dropping some pre-requisites for enrolment and allowing students to study equivalent subjects once they enter university (Michael, 2013, p. 1). This is attributed to fewer students entering universities and studying higher level mathematics in secondary school.

Universities are now offering bridging courses in mathematics to provide students with the necessary mathematics background to succeed in their tertiary studies. A good example is Mc Master University in Ontario, Canada, whereby mathematics lecturers review and prepare manuals that prospective students study during summer before beginning their first year of university mathematics (Kajander & Lovric, 2005). The majority of the students are not well prepared for the fast pace of university mathematics (Selden, 2005).

However, Wilson and MacGillivray (2007) found it of benefit to revisit secondary school content in tertiary courses to assist students for the study of tertiary mathematics. This concurs with the findings of Steyn and Du Plessis (2007) at the University of Pretoria in South Africa who noted that extended study programme at universities offer opportunities for students who are at risk academically or do not meet the entry requirements for a certain course of study. Furthermore, Wood and Solomonides (2008 in Michael, 2013) suggested that it is better not to spend time on what mathematics students had difficulty with at secondary school but focus on how they are developing their mathematics at tertiary institutions. It is important to know what level of mathematics understanding they bring with them, as Michael (2013) puts it. The secondary school mathematics focuses more on problem solving whereas tertiary mathematics involves more abstract thinking and formal proofs, which makes it difficult for students to cope with tertiary mathematics.

Research conducted by (Brainer, Cruickshank & Metcalf, 1995; Kasanda, 2005, Driscoll, 2007; Skemp, 1989; Kilpatrick, Swafford, & Findell 2001, as cited in Ilukena, 2008) has shown that teachers with inadequate mathematical content knowledge will struggle to teach mathematics to their learners. It is only teachers with higher mathematics content knowledge who can set higher-level mathematics tasks that engage learners in understanding mathematics concepts and for Namibian Mathematics teachers to be successful, they need adequate subject matter knowledge, which is referred to as the knowledge of the subject that the teacher needs to teach for understanding (Shulman, 1986; Ball et al., 2005; Davis & Krajcik, 2005; Namibia. Ministry of Education [MoE], 2005b in Ilukena & Schäfer, 2013). They also need to develop pedagogical content knowledge (PCK) and curricular knowledge (CK). The PCK includes knowledge of mathematics – specific strategies and various ways to represent content, and learners' thinking about mathematics, while CK is an array of instructional materials, reinforcement devices and teaching media.

As Mathematics teachers change in their horizons of understanding rather than through

sudden leaps of insight, they need to access 80% of the teacher preparation time on subject content as revealed by international research and the remaining 20% representing pedagogy (Shulman, 1986 as cited in Ilukena, 2008).

Research methodology

This qualitative study employed document analysis and questionnaires to collect data from the sample. A total of 92 questionnaires were given to students but only 39 (42%) questionnaires were returned. Furthermore, school and UNAM curricula documents were analysed and included the UNAM B. Ed (Hons) degree Basic Mathematics course outline , student – lecturer evaluation reports as well as both syllabi for school mathematics (Ordinary and Higher) level Grade 11 – 12.

A case study design was adopted to gain an in-depth understanding of the challenges encountered by first year students registered for Basic Mathematics at the University of Namibia, Rundu Campus.

Results

This section presents findings from the questionnaires, feedback from student – lecturer evaluations reports and the school and UNAM curricula.

Questionnaires

Profile of participants

It emerged that out of a total of 39 mathematics student teachers who returned the questionnaires, 25 were male and 14 were females. Among them, 2 did high level mathematics, 14 did extended while 23 did core mathematics.

Table 1: Mathematics student – teacher statistics

Symbols	A	B	C	D	Level 2	Level 3	**Total**
Frequencies	1	6	27	3	1	1	39

Table 2: Pass and fail numbers in mathematics at Rundu campus

Year of enrolment:	Enrolled:	Passed:	Failed:
2010	1	0	1
2011	32	6	26
2012	7	4	3

From Table 2, 32 students who enrolled in 2011, included one student who had failed in 2010. Among the 26 that failed mathematics in 2011, 15 managed to pass in 2012 while the other 11 who failed registered in 2013 in their 3rd year as the module is not a pre – requisite to the subsequent modules namely, Introduction to Mathematics (EMMU 3512), Mathematics Education 1A (EMMU 3611), Mathematics Education 1B (EMMU 3612), Mathematics Education 2 (EMMU 3780) and Mathematics Education 3 (EMMD 3890) offered in the department of Mathematics, Science and Sport Education (MSSE), Faculty of Education (FoE), (Faculty of Education [FoE], 2013, p. 175).

The strengths and weaknesses of the basic mathematics module

Out of 39 participants, 38 participants indicated that the module was very difficult, hard and complicated to understand, while participant numbered 15 declined to comment. *"Only students with grade 12 high level mathematics pass"* claimed participant 17 The assertion was supported by participants 4, 6, 18, 25, 27, 29, 32 and 39 who claimed that *"high level mathematics should be made compulsory for students who did high level mathematics because core mathematics learners are disadvantaged"* They further suggested that it was better to get rid of core mathematics component at secondary school level. In order to enhance and prepare students for the mathematics subject content topics such as sets, advanced topics from pre – calculus module, analytic geometry and some from basic mathematics module should be included at Grade 12 level.

In addition, some participants (6, 10, 11, 19 and 37) alluded to the issue that the module was supposed to be offered to students doing secondary education and sciences only, due to high level content offered. Therefore to remedy the situation of high content offered in the module, participants 6, 11, 12, 13, 18, 20, 26, 27, 30, 33, 34, 35, 36, and 37 suggested an intervention: The University should introduce a foundation course before registering for basic

mathematics, introduce one mode of study that's a year module. If the intake was high, *"subdivide mathematics student – teachers' into smaller groups of 40 per class during tutorials and extra classes"*.

Feedback from student – lecturer evaluation as per Teaching and Learning Improvement Unit reports (TLIU) UNAM from 2011 to 2013.

The researchers perused through the evaluation report for SMAT 3580 for 2011 and 2013 as well as SMAT 3511 in 2012 with focus on the following areas:

- the mathematics content offered at grade 12;
- the complicity and challenges in terms of the difficulties encountered by mathematics student – teachers in Basic mathematics at UNAM; and
- the way forward on the offered content in Basic mathematics at UNAM.

It emerged from the analysis that the module is tough, hard, very difficult and complicated particularly for students who did not do extended or higher level mathematics at school in grade 12. *"It's really hard and tough to those who did core mathematics at grade 12"*.

"The module is hard and difficult some of us didn't do the extended or high level mathematics at school" (Respondent 10). Moreover, one of them complained *"the module was difficult for me"* (Respondent 12).

The mathematics student teachers further complained that the module was not supposed to be done by *"people majoring in education because it's too tough; it was supposed to be given to people studying engineering, science and secondary education*", *"the content of the module is too much for primary teachers as it only suits the Faculty of Science"*.

Some students even queried the legitimacy of the module "*I don't know what it has to do in the education faculty*" (One respondent said) while other students stated that they were fine with the content in the module *"No problem associated with module, it is interesting and allows the students to be creative"*.

Some respondents further claimed that *"only seniors (repeaters) who understand and proceed with the lessons".*

Proposed improvements to the module

- Equip the library with pure mathematics reference textbooks, as only one prescribed book is available.
- Students registered for this module were expected to work hard and put in more effort in order to pass the module. Students also asserted that they needed assistance and support from the lecturers. As the module is challenging it needs all your attention and assistance from the lecturer *"The lecturer is helpful and supportive both during lecturing, extra classes and tutorials".*
- The module is too broad, however; the timeframe given was too short to master the content. They indicated that: *"The module is overloaded as topics couldn't be covered in a period of 4 months which is 1 semester, better to make it a year module, or else people have to just rush through the module instead of exploring the deeper content".*

Students proposed that topics in the Basic Mathematics module should be sequenced in the following order: Difficult topics such as trigonometry, sequences, sets, partial fractions and binomials should be covered first and the easier topics can be taught towards the end of the semester. *"Lecturing should start at least with difficult topics at the beginning of the year especially last two topics trigonometry (identities) and sequences".*

With adequate support and assistance, the students learned to appreciate the content they had learnt. *"I have learnt a lot of new concepts that I didn't know in grade 12. "I have learnt more especially about sets which is new topic"*. Despite the challenges experienced by a number

of students regarding the complexity of the following topic: sets, partial fraction, trigonometry, algebraic expression; sequence, polynomials some felt that they had mastered these concepts. Some students further suggested that *"…the content can be reduced by considering the relevance of these topics at the upper primary phase in schools"* while others suggested the inclusion of more content.

School and UNAM curricula

The findings from the comparisons of the Ordinary and High level Grade 12 school mathematics syllabi with the B. Ed Basic Mathematics course outline as evident in Tables 3 to 5 showed that, the Higher Mathematics syllabus had more content which was not covered in the Ordinary Mathematics syllabus while the Basic Mathematics course covered substantially more mathematics content than the two school syllabi. Furthermore, the document analysis also revealed that there was a large discrepancy in mathematical content covered in higher and ordinary level school mathematics.

A comparison of Mathematics topics covered by 1st year Basic Mathematics at University of Namibia and School Mathematics for both Higher and Ordinary Levels at Grade 11 & 12 Level is illustrated in the tables below:

Table 3: Ordinary level (Grade 11 & 12) school mathematics curriculum

Course Name	**Description**
Ordinary level (Grade 11 & 12)	• Numbers and Operations • Measure • Mensuration • Geometry • Algebra • Graphs and Functions Coordinated Geometry Trigonometry • Vectors in two dimension and Transformation • Statistics and Probability

Table 4: Higher level (Grade 11 & 12) school mathematics curriculum

Course Name	**Description**
Higher level (Grade 11 & 12)	*Mathematics Part I* • Numbers and Operations Measure • Mensuration • Geometry • Algebra • Graphs and Functions • Coordinated Geometry • Trigonometry • Vectors in two dimension and Transformation • Statistics and Probability *Mathematics Part II* • Polynomials, • Identities, equations and inequalities, • Vectors, • Functions, • Logarithmic and Exponential • Functions, • Absolute value (Modulus), • Trigonometry • Sequences • Differentiation • Integration

Table 5: B. Ed degree (UNAM) Basic Mathematics Year 1 Curriculum

Course Name	**Description**
B. Ed degree (UNAM) Basic Mathematics Year 1	• **Algebraic expressions**. Definition and examples, Simplification, expansion, factorization, polynomials, remainder and factor theorem, quadratic expressions. Binomial expansions, Pascal's triangle and the Binomial Theorem. Rational expressions, partial fractions. • **Sets**. What is a set? Set notation, equality of sets, subsets, characterization of equality via the subset relation, empty set, Venn diagrams, intersection, union, complement, de Morgan's laws, set difference, symmetric difference, proofs of simple results on set equality. Standard examples of sets: natural numbers, integers, rationals, real numbers. Absolute value and intervals in R. A bit about cardinality of sets (examples of finite, infinite,

countable, uncountable sets).

• **Equations and inequalities**. Linear equations in one-variable, simultaneous linear equations, quadratic equations, simultaneous non-linear equations. Linear inequalities, non-linear inequalities.

• **Functions**. Domain, co – domain, image, preimage, even function, odd function.

• **Trigonometry**. Trigonometric ratios, angle orientation in the xy-plane, graphs of trigonometric functions, trigonometric identities, justifying (proving) equality of relatively simple trigonometric expressions. Sum/ difference, double angle, half angle and sum to product formulas.

• **Sequences**. Definition, notation, obtaining the general term in certain sequences, recursively defined sequences, arithmetic sequences, geometric sequences.

It also emerged from the participants in the research that the ordinary school syllabus was of low standard and inadequate to prepare students for the task ahead. This finding concurs with the student – lecturer evaluation feedback of the mathematics student – teachers from 2011 to 2013 which revealed that the module was challenging, tough, confusing, advanced, and difficult for slow students to catch up especially those who were taught at core and extended levels at Grade 12. They further claimed that the Basic Mathematics module should not be compulsory for mathematics student – teachers enrolled for primary education. It was too complicated and had a lot of topics to be covered in one semester. They suggested that it was better if the content would be spread over two semesters.

The first semester could, for example, revisit content covered in Grade 12 integrating the new topics such as inequalities, factorizations, trigonometry (trigonometric functions and identities), binomial theorem, partial fractions, set theory (mathematical reasoning) and functions (range and domain). This will serve as a bridging course to accommodate students who were taught mathematics at ordinary and extended levels at Grade 12, to pave way into tertiary mathematics. It should be noted that, as teacher educators at the university know what types of knowledge and what levels of knowledge acquisition is necessary for our mathematics student – teachers to become effective primary mathematics teachers and what contexts are most conducive to learning how to teach. They need all seven domains of teachers' professional knowledge; knowledge of subject matter, pedagogical content knowledge, knowledge of other contents, knowledge of the curriculum, knowledge of learners, knowledge of educational aims and general pedagogical knowledge as alluded to earlier.

We also found that the majority of our mathematics student – teachers appreciated extra tutorials and remedial classes offered during the week, but they were of the opinion that much needed to be done to effect the perception on how mathematics is taught and handled at school and tertiary institution. The inadequacy in the subject content knowledge at ordinary level and partially at higher level hinders students to comprehend mathematics at university level, because of the terminologies, the mathematics

concepts, use of mathematical techniques, mathematical reasoning, proof and theorem are more advanced at university and mathematics student – teachers' can't make connections with what was taught at secondary school at university. Unless their foundation is secured, it will be extremely difficult to build mathematical and scientific success in comprehending advanced mathematics concepts to cope with tertiary mathematics.

Enrolment and pass rates in the basic mathematics module at Rundu campus 2011 – 2013

Tables 6 and 7 show the enrolment and pass rates since the inception of the Basic Mathematics Modules at Rundu campus in 2011.

Table 6: Students pass rates in Basic Mathematics in 2011 – 2013

Subject Code	New/repeater	2011			2012			2013			Total
		Fail	Pass	Total	Fail	Pass	Total	Fail	Pass	No result	
MAT3511	New	-	-	-	17	15	32	25	10	1	36
	Repeater	-	-	-	12	14	26	29	5	-	34
MAT3511		-	-	-	29	29	58	54	15	1	70
MAT3580	New	50	17	67	3	3	6	6	6	-	12
	Repeater	-	-	-	5	4	9	3	1	-	4
MAT3580		50	17	67	8	7	15	9	7	-	16
Grand Total		50	17	67	37	36	73	63	22	1	86

Table 7: Pass rates in Basic Mathematics from 2011 – 2013

Subject Code	New/repeater	Academic year		
		2011	2012	2013
MAT3511	New		46.90%	27.80%
	Repeater		53.80%	14.70%
MAT3511			50.40%	21.30%
MAT3580	New	25.4%	50.00%	50.00%
	Repeater		44.40%	25.00%
MAT3580		25.4%	47.20%	37.50%
Grand Total		25.4%	48.80%	29.40%

The Table 6 reveals that no mathematics student – teacher sat for Basic Mathematics (SMAT 3511) in June examination 2011, but, they all sat for SMAT 3580 in November examination, 2011. The content in both SMAT 3511 and SMAT 3580 is the same, but SMAT 3511 is offered in Semester 1 while SMAT 3580 is a year module. No mathematics student – teacher

sat for SMAT 3511 due to the fact that the Department of Mathematics in the Faculty of Science, the custodian of the module was not informed by the Faculty of Education that the four merged satellite campuses had started offering SMAT 3511. This is how students from the four satellite campus missed the placement test after four weeks of lectures. However provisions were made to support the satellite campuses in terms of tutorials, seminars, workshops, tests and materials required.

Despite all the efforts made in 2011, only 17 (25.4%) of the 67 mathematics student – teachers managed to pass the final examination in November at Rundu campus. However, there was an improvement in terms of the pass rate in 2012 whereby the new intake of students managed to score 46.9% and 50.0% while repeaters managed to score 53.8% and 44.4% respectively in both modules. In 2013, there was an improvement in the pass rate of the new intake, while repeaters dropped drastically in comparison to 2012 academic year. This was attributed to the backlog (additional modules) as opposed to the new intake; they missed most of the lectures in Basic Mathematics at the beginning of the first semester due to School Based Studies (SBS).

Moreover, this module does not have any pre - requisites and it is not aligned to any of the mathematics education modules in MSSE Department. This implies that the student can carry this module until his/her fourth year of the B. Ed programme, although the academic advancement rules stipulate that by the end of each academic year the student is supposed to pass the remaining modules plus at least 75% of the previous academic year modules to proceed to the following academic year. Unless Basic Mathematics module is made a pre - requisite for any of the mathematics education modules in the MSSE Department, students will continue to perceive it as an irrelevant module introduced to torture them academically. It is imperative that a mechanism is found to remedy the situation.

Discussion

An analysis of the mathematics syllabi and the course outline (See Tables 3 to 5) of the Namibia Senior Secondary Certificate (NSSC) for Grades 11 & 12 programme (Ministry of Education [MoE], 2010a, 2010b) and the UNAM B. Ed (Hons) (Faculty of Science [FoS], 2013, p. 3), confirms that there is a reasonably large gap in both level and area of work covered between the ordinary level and the UNAM syllabus, and to a lesser extent the higher level. This research also reveals that, higher level syllabus has some advanced topics not covered in the ordinary level but covered at University level. The comparison in Tables 3 to 5 seems also to support the claim by the students' evaluation reports from 2011 to 2013 that the ordinary level mathematics syllabus, does not cover much of what is covered in the UNAM B. Ed (Hons) Mathematics syllabus, or it covers it at a lower level and thus students find it difficult to cope or pass this module.

Thus, examinations of the syllabi of these three programmes revealed the following: Firstly, the higher level mathematics course has more content not covered by the ordinary level and some is covered at a higher level. Secondly, the UNAM B. Ed (Hons) degree Basic Mathematics covers substantially more mathematics content than the higher and ordinary levels. The Basic Mathematics further includes a wider scope and greater coverage of more content aspects of mathematics one would expect from a degree course. For example, Tables 3 to 5 indicate that the topics on sets are not part of both Higher and Ordinary school syllabi while polynomials, sequences, functions, trigonometric identities, absolute value (modulus) equations and inequalities are not covered at ordinary level. Algebra and trigonometry are taught in all three courses. Moreover, at higher level UNAM, trigonometry constitutes standard trigonometric functions, graphs and identities unlike at ordinary level where it involves only the three trigonometrical ratios (sine, cosine and tangent). While measure, mensuration, geometry, vectors in two dimension and transformation, statistics and probability are covered at both higher and ordinary level, but not at first year university level. The shortfalls in the ordinary level content when compared to the UNAM Mathematics degree appear (Tables 3 to 5) in the topics such as logarithmic and exponential functions,

differentiation and integration covered only at higher level. This shows deficiencies in the ordinary level mathematics content and should be addressed to enable learners to cope with university Basic Mathematics. It is evident from Tables 3 to 5 and student – lecturer evaluation comments that the level of mathematics at higher level would equip students to cope with Basic Mathematics.

This research further revealed that the aim of the Basic Mathematics course was to introduce students to university mathematics, and required them to work hard, and participate in lectures and tutorials. In order to assist students with a weaker background in mathematics, we found that the Department of Mathematics (FoS) runs two – modes of teaching its first year course. The decision as to which mode a student would take is reached upon after sitting for the compulsory first class test in Basic Mathematics (SMAT 3511), after four weeks of classes. Any student who scores a mark of 40% or higher, in the said test, proceeds with the current mode of study, which enables such a student to complete the first semester mathematics courses in the first academic semester year of registration. The student who scores a mark below 40% proceeds to the slow mode (SMAT 3580), in which the content of first year Basic Mathematics is taught over two semesters.

Conclusion and recommendations

The Faculty of Education at the University of Namibia should devise a mechanism to introduce a bridging course in mathematics content. This is to bring about necessary fundamental changes in the learning of mathematics content in classrooms at university. The purposes of a bridging course include the following:

- *to increase the possibility of prospective student – teachers to acquire and be equipped with advanced content mathematics to perform when enrolled in basic mathematics module;*
- *to encourage the mathematics student– teachers to read around mathematics content; and*
- *to fill the subject content gap among school learners entering the university*.

It is also evident that there is agreement amongst the participants in this study that there is a need to raise the levels of mathematics content knowledge at school level. Therefore we recommend that the following topics are included at school level; set theory, trigonometric identities, and sequences at ordinary level.

The Ministry of Education through NIED should pitch school mathematics to the first year University Basic Mathematics content. This will address the lack of mathematics content knowledge among the Grade 12 learners. We therefore recommend that the Faculty of Education at UNAM should send its first year students in Basic Mathematics a course outline to help them prepare over summer holiday (December – January) before the beginning of the following academic year with detailed content to be covered in the course.

We also recommend that the faster – stream be phased out to have only one stream of Basic Mathematics in the Faculty of Education, for students to acquire more content.

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