

An Assessment Of The Sufficiency Of Mathematics Syllabus D In Preparing Learners Intending To Major In Mathematics Related Courses At University

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Abstract: First year students enter university with low levels of mathematical competencies. There is insurmountable evidence indicating that some mathematics syllabi are not adequate. This shows seriously rippling effects for students wishing to pursue studies involving problem solving. This study aimed at investigating the sufficiency of Mathematics Syllabus D (4024) in preparing learners intending to major in mathematics related courses. The study further aimed at providing explanations for the rampant drop out of mathematics students. It also tried to find ways and means of finding solutions to the scourge. The study followed a primary data analysis and adopted an integral qualitative-quantitative approach. The research question was sub divided into two specific questions and two research hypotheses. The research targeted all the universities offering mathematics in Zambia. However, only two public universities in Kitwe district of Copperbelt province of Zambia were considered. A survey questionnaire was used for data collection. During data collection: students indicated their final grades in Syllabus D and their results from the first year sessional examinations; a 5-Point Likert Scale was completed, and an open ended question on the relevance and adequacy of the syllabus was answered. Data collected was analysed descriptively and inferentially. Chi Square methods were used to analyse quantitative data at 0.05, level of significance. The Statistical Package for Social Sciences (SPSS) software was also used. The Qualitative Data Analysis software (QDA miner Lite) was also used. The main finding was that a student's performance at university in Mathematics differs significantly from his/her performance in Ordinary Level Mathematics. It was also established that a student's performance in First Year University Mathematics is independent of his/her performance in Syllabus D. Furthermore, results indicated that the syllabus enhanced critical thinking and conceptual understanding. However, participants indicated that the syllabus was inadequate and needed more topics.

Keywords: Adequacy and Relevance of a Syllabus, Essential skills, Preparation of Mathematics majors, Sufficiency of Mathematics Syllabus D

1. Introduction

Excelling in mathematics is a key to success at school; opening doors to higher education and some well paying jobs. Mathematics is an important integral part of education for the execution of the goals of education. Education was defined by [50] as a continuous process which the society establishes to assist its members to understand the heritage of the past and to participate productively in the future. Despite the need to excel in mathematics, students consistently perform worse in universities [50]. The performance of students in mathematics at university has remained poor for many years (Matlala, 2005). It is further argued that in Zambia, achievement is far from satisfactory in the areas of mathematics particularly for first year students [41]. [30] Says that learning in the first year of mathematics degree is regarded as a challenging transition for students moving from a high school learning environment to tertiary learning. The difficulties that students encounter during this transitional period and the effects thus can have on students' successes in higher education have been documented in literature nationally and internationally. [30] Further says that students entering university come from a school environment that lacks independent learning. However, at tertiary, there is more freedom than at the secondary school environment. The freedom found at tertiary level usually put students at risks as they fail to catch up with their work. [19]

Gives evidence of an increase in under preparedness of students entering university in mathematics. In general, research conducted by the South African Institution of Physics (SAIP) and the Council for Higher Education (CHE) [45] in some 20 South African universities revealed with great unanimity that the "school mathematics is failing varsity entrants". In particular, the report points towards the under-preparedness that had engulfed the schooling sector over the period of 5 years in South Africa. The report also pointed that students have been left without adequate mathematical and necessary problem solving skills in mathematics (the gateway subject) for university entrance. [29] Also acknowledged that many students are admitted to universities with low mathematical skills. [5] Report of a survey carried out on students and lecturers at University of Southern Queensland (USQ) to discover their perception of how well prepared for any mathematics encounter in first year of study. The study was generally done, this means that it was not only restricted to courses which are predominantly mathematics. From the study, it was concluded that students are not given sufficient information to judge their readiness to commence university studies. Generally, it was found that students were under prepared for their respective courses. The study also showed that only students who had done two different syllabi of mathematics (B and C in the case of Australia) at high school were sufficiently prepared.

2. Literature Review

2.1 Sufficient Syllabus

A sufficient mathematics syllabus in this study operationally means a syllabus which is able to prepare learners to solve their day to day problems. This may be academic, social or/and economical problems. It will further highlight the roles of a teacher and various activities that can be undertaken in a sufficient syllabus. A syllabus is a contract between a teacher and the learners, each of them [35]. She says that a student should be told what they are expected to demonstrate by the end of an instruction. A syllabus is a good avenue used to advertise a course to be undertaken [35]. The teacher has to share with the learner what create an amusement from the content of the syllabus. The teacher should also engage with the students while they are completing activities, wondering aloud and posing questions to the students for promotion of reasoning. Teachers, therefore, should try by all means to develop and change the mindsets of their learners. A mathematics classroom should allow particular activities so that it is viewed more like a science laboratory. Mathematics syllabus should provide differentiated pathways and choices to support every learner [34]. By providing pathways, their potential will be maximised. The syllabus must engage the Twenty First Century learners, who are digital natives comfortable with the use of technologies and who work with this differently. The learning of mathematics must take in cognisance the new generation of learners, the innovations in pedagogies as well as the affordances of technologies. A mathematics syllabus should ensure that all students achieve a level of mastery of mathematics that will serve them well in their lives, and for those who have the interest and ability, to pursue mathematics at the highest possible level [20]. Teachers should also realise that learners are not blank slates; therefore, knowledge can only be imparted when the child makes sense according to the current situation. A mathematics syllabus should also promote a platform to develop quantitative skills. Moreover, mathematics is a subject that explicitly prepares learners for employment in business and economical sector. Every learner of mathematics should develop the ability to solve complex problems not only academic related ones [42]. He goes on to say that solving complex problems is a fundamental skill which is set to tackle everyday challenges. This entails that the application of mathematics in everyday activities is ever increasing because mathematics is more than counting and arithmetic. This means that there will be more and more opportunities to find interesting roles in which one can apply their skills. Mathematics is a science in which new results are built upon earlier results. This form of elaboration reinforces understanding of subject matter, making it easier to remember. When one designs a syllabus, the designer should have the learners' interest at heart [7]. A syllabus should specify the contents appropriate to the learners' background knowledge [63]. He goes on to say that a good syllabus should enable the learners, at the end of the course, to comprehend what they hear, read and be able to write and speak in the target language. This means that a good syllabus in the case of mathematics should be able to train its learners to be able to use the specialised language of a specific subject. A specialised language is the language that enables one to master the subject matter of the particular subject [29]. Mathematics Syllabus D encourages the development of mathematics knowledge as a key life skill and as a basis

for more advanced study [58]. The syllabus aims to build learners' confidence by helping them develop a feel for numbers, patterns and relationships. The syllabus also places strong emphasis on solving problems and presenting and interpreting results numerically and graphically. It also encourages the use of various modes of presenting learning material. It may be iconic, symbolic or enactive [11]. This means that learners should gain an understanding of how to communicate and reason using mathematical concept. Therefore, a relevant syllabus should also ensure that learners are confident in every computation. [40] Say that a good syllabus should encourage teachers to focus on helping students to develop mathematical knowledge and skills. They say that the best way to develop mathematical knowledge and skills is through the process of problem solving, rather than on helping them to find solutions. Teachers of mathematics should prioritise generating class discussion and facilitating mathematical reasoning as students engage in problem solving. [40] Argue that learners should also be encouraged to analyse problems and break them down into manageable steps; those of others, and to adjust their own approach where necessary.

2.2 Preparedness

A major challenge facing many of today's students as they pursue university education is lack of academic preparedness [23]. Lack of preparedness makes half of students entering university to take at least a remedial course to enhance performance. Entering university under prepared in mathematics has a number of consequences [23]. Students who are underprepared may take more years to complete their programs at university. Apart from posing an obstacle to university mathematics success, academic under preparedness can have an impact on an individual's overall well being if it hinders university progression and completion. For instance, in USA, the gap in earnings between university drop outs and university graduates has been rising from time immemorial. The majority of secondary students are graduating from secondary school less prepared academically for advanced level university college mathematics. The persistent decline in mathematics performance of students who transition into university is a phenomenon that continues to be a national phenomenon in the United States, for example. In 2002, only 34% of graduating secondary students had acquired the necessary skills for university level [22]. The study also reported that only 23% of Africa American students and 20% of Hispanic students left school and were ready for university compared to 40% of white students. In Pennsylvania, the study found that 36% of white students were ready for university compared to 46% Asians, 20% Hispanics and 5% Africa American students [1] One of the causes of unpreparedness among students is the disconnection usually experienced between different levels of learning. For example, there is always a disconnection between school mathematics and university mathematics. The mathematician Felix Klein was a pioneer in considering the relationship between school mathematics and advanced mathematics. [26] Recognised the importance of combating the "double discontinuity" for teachers. Teachers experience a first disconnect between school mathematics and university mathematics when pursuing a university degree. The second disconnection is between the mathematical ideas teachers learn at university and the mathematics they later teach at school. Klein

advocated explicit connection between school and advanced mathematics. Many studies have confirmed the weakening mathematical knowledge of undergraduates, even when some levels of mathematical skills are required in all university courses [21]. For instance, in the United Kingdom, it is known that there is a gap in the mathematical and statistical knowledge of entrants in the UK Higher Education Institutes (HEI). Generally, this knowledge gap problem has been in existence for some time now [16]. This is more evident where the courses include use of advanced mathematics and statistics for which a sound foundation is required. Under preparedness has impact on university students who are pursuing Science, Technology, Engineering, and Mathematics (STEM) degree programs that require foundation mathematics [57]. Improving the university mathematics readiness of secondary school students entering college may contribute to decreased remediation rates and degree completion hence helping to improve individual's lifetime earnings and overall welfare. Furthermore, it improves the quality of workforce particularly in science and technology fields. This helps in improving the economic status of a particular nation or the world at large. [34] Says learning mathematics is a key fundamental in every education system that aims to prepare its citizens for a productive life in the Twenty First Century. The development of a highly skilled and well educated man power is critical to support an innovation and technology driven economy. A strong grounding in mathematics and a talent pool in mathematics are essential to support the wide range of value added economic activities and innovations. Mathematics is about productive struggle, solving everyday problems, and seeing patterns in the world around us [32]. He says that patterns are a natural part of mathematics and, therefore, they are inevitable. Consequently, teachers are advised to make their goal to overcome classroom challenges so that students can learn. In other words, the role of a teacher is to prompt and facilitate discussion that should be completed by children themselves. Mathematics should help learners prepare for the challenges they face further in life [61]. Teachers should always be able to engage every child in class (Singh, et al, 2005). They contend that anything less is capable of acting towards systematic exclusion in the long run. They should adequately challenge the talented even when ensuring the participation of all children is a challenge. They further say that offering teachers means and resources to do this is essential for the health of the system, the education system. Students entering university realise that there are differences between the mathematics they were made familiar with at school and mathematics that is taught and discussed at university. Some scholars have gone as far as suggesting that school mathematics and university mathematics are two distinct disciplines [56]. [56] Describes how university newcomers "simply cannot recognise the mathematics", and asserts that "university mathematical discourse is as far removed from what the student knows from school as a discourse" [56]. This means that whatever the student knew it becomes known in a different way. At university, most students struggle with the notion of mathematical proof for example. Generally students do not find learning of mathematical proof to be an easy task in first year mathematics especially. It involves not only learning strategic knowledge in specific areas related to the problem at hand, but also knowledge and norms specific to proof and reasoning [27]. The content is normally left implicit in

discussion proofs in high school, and thus many students arrive unprepared to their first university proof oriented courses. Success in university mathematics depends on the level of mathematics studied at high school. In a study carried out in Canada, [24] found that the amount of time students spent learning mathematics in the final years at secondary school strongly correlated to their performance in a first year mathematics course. [51] Concluded that university students' secondary school background has dramatic effect on pass rates. Students who are under prepared for their university mathematics courses were more likely to withdraw from or worse still fail their first year mathematics courses [48].

2.3. Essential skills

Skills are behaviours that are fundamental in order to accomplish some goals for utilising knowledge and understanding [15]. [5] Gives a number of skills needed by university students in order for them to function well during their learning period. The following are some of the necessary skills: mathematics modeling, Mathematicalisation, mathematical transaction and mathematical verification. Modeling is probably the most important skill for university readiness [52]. For every arithmetic skill a student masters, they should practice and learn modeling techniques and use that skill. Mathematicalisation is a process in which a phenomenon is translated into various mathematics structures. For example; students should be able to do the following: designing a mathematical function, expressing phenomena by symbols and applying mathematical expressions to real life situations. Mathematical transaction is a process in which a mathematical operation is carried out based on a mathematical structure. For example, carrying out a calculation and an operation, logical inferring, and selection of axiom may be some of the particular ways of Mathematicalisation. Mathematical verification is the process which confirms whether or not the mathematical operation was right. Students who are ready to major in mathematics will need to exhibit the following attributes: fluency and facility in algebra will not be an overemphasised attribute [52]. Apart from fluency and facility, algebraic skills are also required for almost every part of university level mathematics, and most university level courses using mathematics. Developing facility in algebra and algebraic skill depends on arithmetic fluency and facility [52]. The ability to use standard algorithms of arithmetic correctly is equally fundamental to a student of mathematics. Furthermore, the ability to model using algebraic skills is paramount both for transition to university and for doing university level work. Children should also be taught practicing skills to enhance future learning in other related courses (fields) which are mathematics related. Understanding of mathematics concepts is very fundamental in the learning process and this includes the ability and familiarity to use it in new association [18]. According to [53], employers are not interested in hiring school graduates who lack the skills and abilities needed to advance beyond entry level jobs. University mathematics courses should signal to employers that candidates have flexibility and intellectual ability to succeed in the work place. The courses should also equip individuals with the critical thinking and analytical skills they will need to navigate multiple jobs and career changes. Students should be equipped to train in skills

that may not yet have been conceived, and they are likely to face throughout their working lives. The intellectual skills cultivated in the study of mathematics are valuable both directly and indirectly to many work settings [2]. The skills needed by employers are the same as those needed by postsecondary faculty members. The ability to develop and apply mathematical thinking in order to solve a range of problems in everyday situations is important for all learners [52]. Mathematics is important for learners to acquire a sound knowledge of numbers, measures and structures, basic operations and basic mathematical representations. Learners also acquire an understanding of mathematical terms and concepts, and an awareness of the questions to which mathematics can offer answers. Another skill which learners entering an institute of higher learning need is mathematics fluency. Through mathematics fluency, learners are provided with opportunities to deepen their knowledge and reasoning. Learners may be more formally into contact with abstract and logical reasoning. They may also better appreciate and apply the communication possibilities that mathematics medium offers [34]. Mathematics underpins many aspects of our everyday activities, from making sense of information in the newspaper to making informed decisions about personal awareness [40]. A good understanding of basic mathematics is essential wherever calculations, measurements, graphical, interpretations and statistical analysis are necessary. [64] Says that the learning of mathematics also provides excellent vehicle to train the mind, and to develop the capacity to think logically, abstractly, critically and creatively. These are important Twenty First Century competencies that we must imbue in our learners so that they can lead a productive life and be lifelong learners. [60] Argues that teachers need to know where their students are coming from and where they are going in mathematics. [12] Says that mathematics is a logical subject; this means that learners of mathematics should develop the ability to argue clearly and concisely as they solve problems. He goes on to say that this way of thinking or solving problems must be a goal of every mathematics scholar. Learners may also want to discover new ideas and heuristics so as to realise that mathematics is a subject that should be enjoyable. The teacher should lead the students through questions and activities to discover, discuss, appreciate and verbalise new knowledge. Students who participate in problem solving based learning activities can improve their ability to retain and recall information; this is according to a literature review about the pedagogy.

2.4. Mathematics majoring

The number of professionals relying on mathematics is ever growing [6]. This is prompted by many innovations and technologies coming alongside with the twenty first century skills. In the same vein, the mathematical sophistication of mathematically oriented professions is ever increasing. However, this does not mean that sophisticated mathematics is a prerequisite for majoring in mathematics related courses. In other words, it simply means that mathematics cannot be avoided in every modern society. Students who major in mathematics are expected to encounter statements, instructions, or information framed mathematically. Mathematics related courses are widely recognised as crucial areas for the development of modern society [16]. This is because of the many contributions mathematics makes to innovation, economic growth and progression. In a world where organisations seek persons with mathematical and

statistical skills to ensure increased productivity and value for money, there are implications on the employability of students lacking such skills. Mathematics majors today have more career opportunity in diverse fields than before [60]. Students interested in pursuing mathematics degree programs are availed with many options. They may do any of the many relevant fields of their choice at a given tertiary institution. Mathematics provides a great preparation for a variety of jobs. Nowadays, employers are desperate for applicants that have mathematics background and problem solving skills. Mathematics majors are increasing on demand. Mathematics can provide critical thinking skills and technical training that can provide one with numerous fulfilling higher paying jobs. [13] Says that the development of every economy entirely depends on its citizens' capacity to succeed in jobs that require advanced knowledge and skills. These kinds of jobs are only available to those who have earned a bachelor's degree in a relevant programme. [13] Says that much of the Twenty First Century science and engineering is built on a mathematical foundation. The reach of the quantitative sciences are fuelling innovations and discovery in many areas. Medicine, manufacturing, transportation, communication, finance and other economic enterprises depend on the mathematical sciences [13]. Mathematical sciences consist of mathematic, statistics, operations research and theoretical computer science. There is needed to change the notion of mathematics as something to be feared to mathematics that can contribute to a learner's career objective and the quality of her or his life [13]. The impact of majoring in mathematics related courses is evident in salary gaps once young people enter the work force. There are many effects related with majoring in mathematics related courses [2]. For example, the annual earnings of a student who majored in mathematics related course in the United States is 65% higher than that of another who majored in a non mathematics related course. Furthermore, workers who lack advanced mathematics skills will not only earn less, they will also struggle to find satisfying employment [2]. Outlines some of the requirements for students intending to major in mathematics related courses at a university. Students need to understand mathematics in general before entering any university. In other words, it simply means that mathematics cannot be avoided in every modern society. Students who major in mathematics are expected to encounter statements, instructions, or information framed mathematically. Mathematics related courses are widely recognised as crucial areas for the development of modern society [9]. This is because of the many contributions mathematics makes to innovation, economic growth and progression. In a world where organisations seek persons with mathematical and statistical skills to ensure increased productivity and value for money, there are implications on the employability of students lacking such skills. Mathematics majors today have more career opportunity in diverse fields than before [61]. Students interested in pursuing mathematics degree programs are availed with many options. They may do any of the many relevant fields of their choice at a given tertiary institution. Mathematics provides a great preparation for a variety of jobs. Nowadays, employers are desperate for applicants that have mathematics background and problem solving skills. Mathematics majors are increasing on demand. Mathematics can provide critical thinking skills and technical training that can provide one with numerous

fulfilling higher paying jobs. [13] Says that the development of every economy entirely depends on its citizens' capacity to succeed in jobs that require advanced knowledge and skills. These kinds of jobs are only available to those who have earned a bachelor's degree in a relevant programme. [13] Says that much of the Twenty First Century science and engineering is built on a mathematical foundation. The reach of the quantitative sciences are fuelling innovations and discovery in many areas. Medicine, manufacturing, transportation, communication, finance and other economic enterprises depend on the mathematical sciences [13]. Mathematical sciences consist of mathematic, statistics, operations research and theoretical computer science. There is needed to change the notion of mathematics as something to be feared to mathematics that can contribute to a learner's career objective and the quality of her or his life [13]. The impact of majoring in mathematics related courses is evident in salary gaps once young people enter the work force. There are many effects related with majoring in mathematics related courses [2]. For example, the annual earnings of a student who majored in mathematics related course in the United States is 65% higher than that of another who majored in a non mathematics related course. Furthermore, workers who lack advanced mathematics skills will not only earn less, they will also struggle to find satisfying employment [2]. Achieve [2] outlines some of the requirements for students intending to major in mathematics related courses at a university. Students need to understand mathematics in general before entering any university. By understanding mathematics, students need to think conceptually and not just procedurally. They should be able to use logical reasoning and common sense to find mathematical solutions. Experimental thinking should also be employed, that is taking risks and accepting failure as part of the learning process. In United Kingdom, students intending to major in mathematics related courses are required to achieve high grades in A- level mathematics [60]. This is a prerequisite which is needed in order to study the subject (mathematics) in most of the British universities. For this reason, most universities in the United Kingdom are making further mathematics a compulsory entry requirement. The undertaking of 'A- level further mathematics' mean that some universities are now changing structure and content of the first year of their degree to accommodate the changing mathematical background of their students [55]. [50] Considered the mastery of a particular knowledge of mathematics to be an essential skill for mathematics related courses such as engineering. Mathematics is also considered as the language of communication for scientists and engineers [8]. Furthermore, the logical rigour defined by mathematics encapsulates the quality of knowledge required for engineers [8]. The mathematics education component plays an important role in the studies of engineering students [40].

3. Methodology

3.1. Research design

This study used a cross sectional study design [30]. It is also known as one short or status studies that investigate things such as the prevalence of a phenomenon, situation, problem, attitude or issues by taking a cross section of a population. This cross sectional design was used carried out to assess the sufficiency of mathematics' syllabus D in preparing learners

intending to do mathematics related courses in universities. In this study, the researcher used survey questionnaire method.

3.2. Participant and setting

Survey method was used to collect data of the study. The study was conducted in two public universities of Kitwe district of the Copperbelt Province of Zambia. In particular, the study was done at Copperbelt University and Mukuba University. The two universities were purposefully and conveniently selected as they are the only two public universities where the researcher was too sure of finding students majoring in mathematics. The two universities are also conveniently loc located in terms of where the researcher was based at the time of the research.

3.2. Research instruments

In order to assess the sufficiency of syllabus D in preparing learners intending to major in mathematics related courses, the researcher developed survey questionnaires. The questionnaires were distributed to university students who were in the second year of study. The questionnaire consisted of two parts: the first part concentrated on demographic information about learners. Learners indicated their gender and year of study. Furthermore, the students were required to indicate the grades they got at their final year examination at secondary school. Students were further required to indicate the grades they scored during their first year sessional examination. The second part of the questionnaire was in a form of a five (5) point Likert scale and one question in which learners were required to write briefly about their general comments on the syllabus.

3.3. Validity and pilot testing of the research instruments

Face validity and content validity were done by the researcher. A pilot test of the research instruments was conducted using 10 randomly selected learners outside the study population. Thereafter, with the help of peer check, the research instrument was fine tuned accordingly. The questionnaire reliability was identified by internal consistency coefficient "Cronbach's alpha" method [15]. Cronbach's alpha method is based on calculation of the coefficient between the different items on the same questionnaire. Using the aforementioned method, all the ten (10) items demonstrated coefficient values of each construct and for all Likert scaled questions in the questionnaires were within the acceptable range as in table 1

Table 1: Likert Scaled Questions Reliability Coefficient

Construct	Number of Items	Cronbach's Alpha
Relationship between Syllabus D and Foundation Mathematics	2	0.739
Relevance of Syllabus D to a mathematics student	2	0.743
Retention of Mathematics Syllabus at secondary level	2	0.756
Promotion of Critical Thinking and Conceptual Understanding	2	0.756
Adequacy of Syllabus D to a mathematics student	2	0.770

3.4 Sampling design

The Copperbelt University and Mukuba University have been purposefully and conveniently selected. This is because the two universities are likely to accommodate a good number of students who might have done well in mathematics syllabus D. The two universities also have the largest number of students who do mathematics in Zambia and they are closely located to avoid financial expenses for the researcher. At each of the universities, second year students were purposefully and conveniently selected as they had just written their sessional examinations and they could easily compare between mathematics syllabus D and foundation mathematics. It was also convenient for the researcher as he was working as a tutor at the Green University. At Copperbelt University, a population of 150 second year students studying pure mathematics was targeted. Nevertheless, the researcher drew a sample of 60 from the population using a confidence level of 95% and a confidence interval of 10. Similarly, at Mukuba University, a sample of 60 was drawn from a population of 90 second year student studying mathematics and science using a confidence level of 95% and a confidence interval of 8. Survey software Sample Size Calculator adopted from Creative Research Systems was used in both cases.

3.5 Data collection

Data collection was done by self determination of the final version of the questionnaire, after getting ethical approval from the respective university authorities in order to conduct the study. The questionnaires were distributed among selected second year students at the two universities. The participants were asked for their willingness to participate in the study and verbal consent was obtained, essential instructions and information about how to fill up the questionnaire were explained to them. The participants were given enough time to answer the questions. At the green university, students were able to answer questions within 30 minutes. However, at Mukuba University students were given the whole day to answer questions at their convenient.

3.6 Data analysis

The data obtained for this study were analysed by adapting of both descriptive and inferential statistics so as to provide triangulation and easy interpretation. The distribution of the sample according to gender was shown by means of frequency tables and percentages. Furthermore, Chi Square goodness of fit test was used to investigate whether the grades obtained at secondary school are a good fit to the performance at a university. Chi Squared test of independence was also used to show the relationship between the marks obtained at grade twelve and those obtained in the sessional examination in first year at a university. The significant level of 0.05 was used. Most of the quantitative analysis was accomplished by the use of the Statistical Package for Social Sciences (SPSS) version 20. Data obtained from Likert scale were analysed qualitatively by taking frequencies, percentages and means of the responses.

4. Results

Table 6: Expected relationship between grade 12 results and MA 110 sessional results

Grade obtained in final exam	Expected class in MA 110
ONE (1)	B ⁺ , A, A ⁺
TWO (2)	C, C ⁺ , B

Table 6 shows the expected performance for the students in MA 110 at the Green University. Particularly, a student who obtained a one grade in the school certificate final examination is expected to score in the range of B⁺- A⁺. Similarly, a student who obtained a Two (2) in the final examination at grade 12 is expected to score in the range of C-B in MA 110

Table 7: Number of students according to their observed scores and their expected Scores during their sessional examination Frequencies MA110_MARK

Category	Observed N	Expected N	Residual
1 B ⁺ A, A ⁺	35	57	-22
2 C, C ⁺ , B	25	3	22
Total	60	60	

Table 7 indicates that there were 57 students who had obtained distinction of first grade (1). However, only 35 of the total number (60) could get either B⁺, A or A⁺ in the MA 110 Sessional examination. Similarly, the table further shows that only 3 out of 60 students had obtained a second grade distinction (2) and this is the number that was expected to score in the range of C-B. Nevertheless, the number of students in this range increased to 25. Furthermore, the number 22 represents the reduction of those who were expected to be in the first class B⁺ - A⁺

Testing the first Null Hypothesis

H₀: There is no relationship between the performance of a student in mathematics syllabus D and his/her performance in foundation mathematics at a university

Test: Goodness of fit

	MA	110	MARK
Chi Square	df		Asymp. Sig
169.82 ^a	1		0.000

Table 8 shows that the result were statistically significant that is $X^2(1, N=60) = 169.82, P < 0.05$.

Table 10: Cross Tabulation for Final Grade and MA 110 Sessional Mark

	GRADE	MA110_MARK		Total
		B ⁺ -A ⁺	C-B	
	1.00	35	22	57
	2.00	0	3	3
Total		35	25	60

Table 10 indicates that out of 57 students who got first class ones, 35 of them got Either B⁺, A or A⁺ in the MA Sessional Examination . However, 22 of the 57 could only either score C, C⁺ or B in the Sessional Examination. On the other hand, in the grade 12 final examination, there Were 3 who got second class distinction and all of them could only manage to get C, C⁺ or

Testing the second Null Hypothesis

H₀: There is no relationship between the performance of a student in MA 110 and his/her performance in mathematics syllabus D.

Chi Square Test for Independence

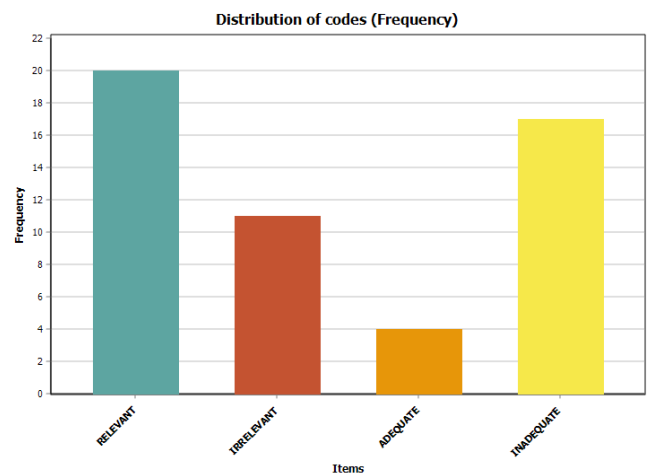
	Value	df	Assymp Sig	Exact
Pearson Chi Square	4.421 ^a	1	0.035	
Fisher's Exact Test				0.067

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.25. b. Computed only for a 2x2 table From table 11, the researcher used Fisher's Exact Test which shows that the exact P value is 0.067 and this value shows that the results are not significant as this value is greater than 0.05 which is the level of significance.

Summary of Likert Scaled Responses from Copperbelt University Data

Student's feeling	Number agreed	Percent
Relationship between the two syllabi	39	65
Syllabus D is relevant to a student	40	67
Syllabus D enhances critical thinking	37	62
Syllabus D does not need to be revised	27	45
Syllabus D is adequate for a student	21	35

Figure 3: Students' responses on the relevance and adequacy of mathematics syllabus D obtained from Green University



From figure 3, there were 53 responses to the open ended question in the questionnaire where students were required to give their views on the relevant and adequacy of mathematics syllabus D. Of the 53 responses, 20 indicated that the syllabus is relevant, 11 said that the syllabus was irrelevant. On the other hand 17 responses indicated that the syllabus was inadequate and only 3 indicated that the syllabus was adequate.

Table 21: Expected relationship between grade 12 results obtained and MAT 110 sessional results

Grade Obtained in Final Examination	Expected Class in MAT 110
1	A-A ⁺
2	B ⁺
3	B
4	C-C ⁺

Table 22: Students according to their observed scores and expected scores during the MAT 110 sessional examination

	Observed N	Expected N	Residual
A-A ⁺	13	14.0	-1.0
B ⁺	10	14.0	-4.0
B	6	15.0	-9.0
C-C ⁺	31	17.0	14.0
Total	60		

From table 22, it is indicated that 14 students were expected to score either A or A⁺ but the number reduced to 13. Another 14 of students were expected to get B⁺. However, the number reduced to 10. Similarly, 15 students were expected to score B but only 6 managed to get grade B. All in all only 17 students were expected to score either C or C⁺ but the number for this class.

Testing Null Hypothesis one

H₀: there is no difference between the performance of a student in MAT 110 and his/her performance in Ordinary Level Mathematics Syllabus D

Test: Chi Square Goodness of Fit

MAT 110	Chi Square Value	Df	Assymp Sig
	18.160	3	0.000

Table 23 shows that the results are statistically significant that is $X^2(3, N = 60) = 18.160, P < 0.05$. From the result, the null hypothesis is rejected and the conclusion is that the difference exists between the performance of a student in MAT 110 and his/her performance in Ordinary Level Mathematics Syllabus D.

Table 25: Cross Tabulation between Final Examinations and MAT 110 Sessional

Count		MAT110MARK			
		A-A+	B+	B	C-C+
FINALGRADE	1	5	2	2	
	2	4	2	0	
	3	1	1	3	
	4	3	5	1	
Total		13	10	6	

Table 25 shows that out of the 14 students who got ones in the final examination at grade 12, 5 scored either A or A+, 2 got B+, 2 got B and 5 got either C or C+. Of the 14 who scored 2 in grade 12, 4 got either A or A+, 2 got B+ and 8 got either C or C+. Of the 15 who scored 3 in grade 12, only 1 got in the range of A-A+, another 1 got a B+, 3 got B and 10 either got C or C+. Lastly, out of 17, 3 either A or A+, 5 got B+, only 1 got a B and 8 got either C or C+.

Testing Null Hypothesis Two for Orange University Data

H₀: There is no relationship between a student's performance in MAT 110 and his/her performance in Ordinary Level Mathematics Syllabus D.

Test: Chi Square test of independence

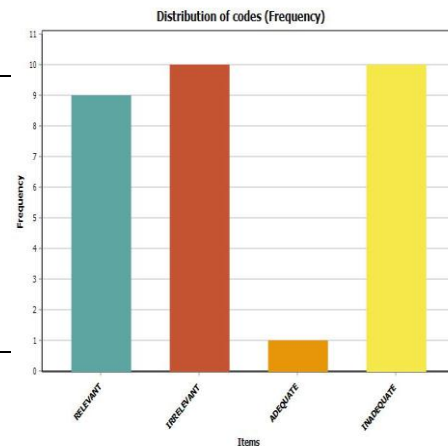
Pearson's Chi Square	Likelihood ratio Sig	Df	Assymp Sig
Likelihood Ratio Test	0.198	9	.285

12 cells (75.0%) have expected count less than 5. The minimum expected count is 1.40.

From table 26, the researcher used the Likelihood Ratio in which the P value is 0.198 which is greater than 0.05 and this shows that the results is not significant. Therefore, the null hypothesis is not rejected and the conclusion is that there is no relationship between a student's performance in MAT 110 and his/her performance in Ordinary Level Mathematics Syllabus D.

Summary of Responses from Likert Scale Items from Mukuba University (N=60)

Student's Feeling	Number Agreed	Percent
There is a relationship between syllabus D and First year University Mathematics.	41	68
Syllabus D is relevant to a student intending to major in mathematics.	36	60
Mathematics Syllabus D enhances critical thinking and conceptual understanding.	35	58
Syllabus D does not need to be revised as it serves a good purpose for students.	25	42
Syllabus D is adequate for students intending to major in mathematics.	22	37



From figure 5, Out of 30 students, 9 students indicated that the mathematics syllabus D is relevant, 10 indicated that the syllabus is irrelevant, 1 student indicated that the syllabus is adequate while 10 other students indicated that the syllabus is inadequate.

5. Discussion of Results

5.1. The relationship between mathematics syllabus d and first year university mathematics

Data on the relationship between mathematics syllabus D and First Year Mathematics was collected using survey questionnaires. It is also important to note that one of the objectives of this study was to determine the relationship between mathematics syllabus D and first year university mathematics. For this reason, data was analysed with a question in mind which read as "Is there a relationship between mathematics syllabus D and first year mathematics?" To answer the above question, data was analysed using a Statistical Package for Social Sciences. The test statistic used was Chi Squared test of independence and a 0.05 level of significance was used. However, the results from both universities did not show a statistic difference. From Green University, a 2x2 contingency table was used due to the fact that students belonged only two categories. From the contingency table, one assumption was violated as there was one cell which contained a frequency of 3. The assumption violated is that the frequency for all the cells in a 2x2 table should at least be 10. For this reason, the P-Value for Fisher's Exact Test was used to compare to the level of significant. The P- Value for Fisher's Exact Test was 0.067 which is greater than 0.05. This means that there was no relationship between mathematics syllabus D and first year university mathematics. On the other hand, a 4x4

contingency table was used since students belonged to four categories. Similarly, using this table, another assumption was violated. The results from the analysis showed that 12 out of 16 cells had less than 5 frequencies representing 75% of the total cells. For this reason, the Likelihood Ratio test was used to analyse the data. Consequently, the P- value for the Likelihood Ratio was compared to the level of significance. The P- value for the Likelihood Ratio was 0.198 and this value is greater than 0.05. This shows that the results were not significant meaning that there is no relationship between mathematics syllabus D and first year university mathematics.

5.2. The Performance of a student at secondary school in mathematics syllabus D and his/her performance in First Year University Mathematics

Data on the performance of students at secondary school in mathematics syllabus D and his /her performance in first year mathematics was collected. Another objective of this study was to determine whether the performance of a student at secondary school in mathematics syllabus D differ with his/her performance in first year university mathematics. During analysis, the question in mind was “does the performance of a student at secondary school in mathematics syllabus D differs significantly from his/her performance in first year university mathematics. Likewise, the Statistical Package for Social Sciences (SPSS) was used and the Chi Squared goodness of fit was used as a test statistic. After the analysis was done, the results from Green University showed a significant statistical difference. The level of significant used was 0.05 and the P Value obtained from the test was 0.000 which is less than 0.05 ($P < 0.05$). This, therefore, means that the performance of a student at secondary school differed significantly from his/her performance in first year university mathematics. Results from Orange University for the above mentioned objective were also analysed using the Chi Squared Goodness of Fit. Similarly, the result indicated a significant difference giving a P value of 0.019 which is less than the level of significance of 0.05 ($P < 0.05$). This also confirms that the performance of a student at secondary school differed significantly from his/her performance in first year university mathematics.

5.2.1 The relationship between secondary school mathematics and First Year University Mathematics.

65% of students from the Copperbelt University indicated that there was a relationship between the mathematics they learnt at secondary school and the one they learnt in the first year at the university. In particular, this proportion includes both those who agreed and those who strongly agreed. Since 35% of the 60 participants did not agree, it means that the relationship that exists between the two types of mathematics is not very strong. From the Mukuba University, 68% of the students also indicated that there was a relationship between secondary school mathematics and university mathematics. Likewise, this result indicates that there is quite a relationship between the two types of mathematics.

5.2.2 Relevance of Secondary School Mathematics to a student of Mathematics at a University

67% of students from Copperbelt University indicated that the mathematics they learnt at secondary school is relevant to someone studying mathematics at a university. However, this indicates that the mathematics done at secondary school is

not very relevant to a student majoring mathematics at a university. On the contrary, from Mukuba University, the number of those who said that ordinary level mathematics was relevant to someone studying mathematics related courses was smaller than those from the Copperbelt University. From Mukuba University only 60% agreed to the question. Since the proportion of those who did not agree was 40%, it entails that the students were undecided on the relevance of the syllabus.

5.2.3 Enhancement of Critical Thinking and Conceptual Understanding

62% of the students from the Copperbelt University indicated that the mathematics done at secondary school enhances more conceptual understanding than rote learning. From Mukuba University, 58% of the students indicated that the mathematics taught at secondary school promotes more understanding than memorisation. Results from both universities indicated that the syllabus does not ultimately promote conceptual understanding.

5.2.4. The Need to Retain the Mathematics Syllabus (4024)

From the Copperbelt University, 45% of the students indicated that the type of mathematics they learnt at secondary school is not good enough to meet the demands of university mathematics. They further indicated that the syllabus needed to be changed. Similarly, from the Mukuba University, 42% of the students indicated that Ordinary Level Mathematics is not good enough for preparing a student intending to study university mathematics. They further went on to say that the syllabus needed to be changed or better still revised.

5.2.5. The Adequacy of Mathematics Syllabus D in preparing a student who intend to major in a mathematics Related Course at a University

From the Copperbelt University, only 35% of the students indicated that the content of the mathematics syllabus taught at secondary school was enough in preparing students who intend to major in mathematics related courses at a university. From the Mukuba University, only 37% of the students indicated that the content of Ordinary Level Mathematics was good enough in preparing students intending to major in mathematics at tertiary level.

5.6. Participants' responses to the open ended questions on the Relevance and Adequacy of Ordinary Level Mathematics

To analyse the responses from participants, the researcher used Qualitative Data Analysis (QDA Miner Lite) software to convert qualitative data to quantitative one. The following were the findings on the open ended question: From the Copperbelt University, 53 responses were given and participants' views fell in four categories: Relevant, Irrelevant, Adequate and Inadequate. Of these, 20 indicated that the syllabus was relevant, 11 indicated that it was irrelevant. Conversely, 17 responses indicated that the syllabus was inadequate and only 3 indicated that the syllabus was adequate. From Mukuba University, 30 students stated their views by writing brief notes on the Ordinary Level Mathematics Syllabus. Of the 30 students, 9 indicated that the syllabus was relevant, 10 indicated that the syllabus was irrelevant. On adequacy, 1 student indicated that the

syllabus was adequate while 10 indicated that the syllabus was inadequate.

6. Conclusion

The findings were presented in three categories. The first part was the interpretation of data which was analysed quantitatively by using the SPSS package and the two Chi Squared methods. The second part was the interpretation of data obtained from the Likert Scale and the interpretation was done qualitatively. The last part was the interpretation of the data obtained from the open ended question which was converted from qualitative to quantitative using Qualitative Data Analysis (QDA Miner Lite) software. The first finding from the quantitative data was that the performance of a student in first year university mathematics differs significantly from his/her performance in ordinary level mathematics. It was also established that there was no relationship between the mathematics taught at secondary in mathematics syllabus D and the mathematics taught at a university. Some participants indicated that the syllabus is relevant as it enhances the engagement of a student in critical thinking and allows them to understand conceptually. However, participants indicated that the syllabus was inadequate to meet all the demands of university mathematics. They also indicated that the syllabus needed to be revised and enriched.

7. Recommendations

Based on the findings and the researcher's experience, the following are the recommendations: the Ministry of General Education through the Curriculum Development Centre (CDC) should design a curriculum which emphasises on continuous assessment. During secondary school, students should undergo both summative and continuous assessment. This is to acquaint them to the system they would find at university. Students should get used to learner centred approaches before entering a university. The Ministry of General Education through CDC should also design a new Ordinary Level Mathematics Syllabus. The syllabus should have most of the topics which are in first university mathematics. The syllabus should also be based on the principles of Constructivism. The topics to be included in the new syllabus should also have adequate depth and emphasis on proficiency [43]. In other words, the syllabus should be written in a way that fosters the spirit of problem solving. The ministry through Zambia Association for Mathematics Education should organise In - Service trainings with regard to teaching and assessment methods. Additionally, the curriculum for teacher training institutions must be improved. In particular, the teachers should train in topics related to what they would teach in the field. The syllabus should also be split into two components: Core mathematics for average performers and Extended Mathematics for talented students. Students should be allowed to select the learning outcomes that relate to their career aspirations. The curriculum should not be loaded with irrelevant topics; only those which are relevant to the academic growth of students. The Ministry of Education should also consider making Additional Mathematics compulsory. This quest will curb the rampant drop outs in first year for STEM students. The emphasis in the curriculum should be for both the affective and the cognitive domain. This will help students before they reach university to learn how to be good students. When children learn how to be good students, they will overcome

mathematics anxiety. Mostly, students have some general academic risk factors as they enter university. These factors may include: lack of self discipline, being unmotivated, having a fixed mindset, little meta-cognition, and having no self efficacy. Mathematics textbooks incorporating practical application of mathematics concepts should be developed. The Ministry should also improve staffing of qualified teachers of mathematics at grade 12 level. The Ministry of General Education should also be holding staff development workshops. The ministry through the Examinations Council of Zambia should change the modes of assessment. The assessment should be encouraging mathematisation abilities rather than procedural knowledge. The Ministry of General Education through ZAME should organise periodic seminars and workshops for students and teachers. Collaborative learning must be organised through group work methods and study groups. At secondary school, learners should always be encouraged to use the library. The books must be available to learners so that they may be acquainted with self learning. At secondary school level, learners should be taught to learn independently. Higher university entry scores and high self efficacy are related to higher achievement (Feldman, 2002). Learners intending to pursue STEM courses should be encouraged to take additional mathematics. This will lay a good mathematical foundation for the rigour of university mathematics. Schools should give the gifted learners the opportunity to increase their mathematical skills. This will increase the likelihood of graduating from university. Universities must be informing students of the requirements in mathematics for their degree. [25] called this requirement 'assumed knowledge'. Students, who are at high risk of achieving poorly, should undertake pre entry courses. These students should be given unambiguous direction if they lack the "assumed knowledge". Universities should also be informing prospective students of the appropriate level of mathematics needed in first year. According to [48] well informed and prepared students performed better than even those who were given bridging courses. At secondary school, there must be emphasis on core topics such as: algebra, geometry, analysis and many more. Students should be tested for proficiency while at secondary school. Those who are not proficient in mathematics should have to hone necessary skills before leaving secondary school. Guidance Councilors should be encouraging students who want to pursue a career in STEM to enroll either for ADMA or A' Level mathematics. Teachers should be enriched with a variety of mathematical resources in order to motivate learners. They should also be encouraged to complete the syllabus. Teachers should always engage learners with a sense of success as well as offering conceptual challenges to the emerging mathematicians. Teachers through ZAME should be encouraged to deepen learners' interest in mathematics. They should help learners to gain a deeper understanding and appreciation of mathematics. Teachers should develop skills of motivating pupils to enjoy learning and doing mathematics. Learners should be able to see and appreciate the beauty of mathematics. Teachers should be encouraged to teach all strands of secondary school mathematics effectively. They should also be able to differentiate instruction for different Students, including special education and English proficient students, while remaining true to the mathematics goal and expectations of the curriculum. The research should be extended to all the universities offering mathematics related courses. This is to confirm the validity

the conclusion as a true reflection of what is prevailing in institutions of higher learning countrywide. A study should be carried out to establish the relationship between the types of mathematics syllabus a student took at secondary school and his/her performance at university in first year university mathematics. A study should be carried out to establish the relationship between the types of school a student attended at secondary school and his/her performance in first year mathematics at a university.

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