Can University Mathematics be Taught Differently? Possibilities and Challenges

Maureen Kanchebele-Sinyangwe (PhD)[1], Harrison Daka (PhD)[2]

[1]Kwame Nkrumah University, School of Education, Zambia

[2]University of Zambia, School of Education, Zambia

Abstract. The aim of this study was to explore the perceptions of first year Mathematics undergraduate students of the modes of teaching that might be seen to support them in learning Mathematics. The study originates from an initial tracking of first year undergraduate students, taking Mathematics as part of the programme they enrolled in, over a period of three years before the start of this research study, whereby this first year Mathematics course was considered a 'killer course' and the most feared one. Explanatory sequential design was used where qualitative data was used to explain quantitative data. The target population for this study was 182 students taking Mathematics as one of their first year courses at Kwame Nkrumah University in Central Zambia. Data was collected via questionnaires, with open and closed questions, and semi-structured interviews. Student's responses indicate that the way Mathematics is taught affected them in learning it. They identified modes of teaching that could support them in learning Mathematics and overcoming their fears. The paper concludes that the identified ways of teaching may need to be considered alongside the lecturer's characteristics and perceptions of teaching Mathematics at University level as well as the student's personal perceptions related to learning Mathematics at University level. From the findings, the study recommends that lecturers need to adjust the ways of teaching by allowing students to get more involved during lessons, speak words of encouragement to students so as to change their negative perception about the subject and lastly lecturers should use appropriate teaching aids to help students understanding.

Key words: Modes of teaching, Mathematics, perceptions

Introduction

The teaching and learning of mathematics at university level has been a source of concern in the education sector for a long time in Zambia. This worrying concern is well reported on the continuous low poor performance of learners in Mathematics and national examinations levels in schools (Examination Council of Zambia, 2016; 2017). This poor performance in mathematics in universities has had an effect on the number of teachers in secondary schools as different studies have reported the shortage of Mathematics teachers in schools (Japanese International Cooperation Agency, 2014; Kafata, 2016).

Due to the fear of failure, studies by Changwe and Mulenga (2018) reported that comparably small number of students entering university to study Mathematics. This means that the few teachers of mathematics in secondary schools will be overloaded to teach many classes and this might result into low quality of education as the student – teacher ratio shall be high. Teachers of mathematics will not be able to have time to attend to slow learners or use teaching methods which can help bring about learning.

The progression rate from 1st to 4th year at Kwame Nkrumah University in mathematics programme has been low (Field Data, 2019). It should be mentioned that low retention rate can be as a result of many predictors. Knowing predictors of academic failure and success is also important for the trainers of mathematics teachers that are trying to ensure high completion rates so that they can develop support mechanisms for students with inadequate performance (Daka, 2019a; Daka, Banda & Namafe, 2020).

Enrolling into university represents the start of a demanding and stressful period for students (Daka, Chipindi & Mwale, 2020). Despite a multitude of social, academic, and

emotional stressors, most students successfully cope with a complex new life role and achieve academic success. Other students are less able to successfully manage this transition and eventually fail to progress to the next level or to graduate (Billings & Halstead, 2005). Therefore, there must be some factors which lead to their failure to progress to other levels in mathematics.

It has been stated that no two individuals learn in the same way, nor do they bring the same prior knowledge to a learning experience (Farmer, 2004). The way we learn is as unique as our fingerprint (Daka, 2019a). This means that for quality of learning to take place, there is need to use a variety of teaching strategies. Cognitive learning theory is based on the idea that humans process information which they receive (Daka & Changwe, 2020). This happens when the learner plays an active role in seeking ways to understand and process the information received. Some examples and applications of cognitive learning theory include discussion and problem solving among many other teaching approaches (Daka, Namafe & Katowa-Mukwato, 2019).

Daka, Namafe and Katowa-Mukwato (2019) and Daka and Changwe (2020) pointed out that instructional designers should determine instructional methods and strategies that would help learners to acquire understanding. During the instructional designing, it is important to put into consideration different approaches to learning and teaching so that all learners are helped in acquiring the required knowledge quality (Osborne, 2013). It is thus clear that management of teaching and learning activities is a component in educational quality that might help students perform well in mathematics at university level.

The purpose of this study was to explore the perceptions of first year Mathematics undergraduate students of the modes of teaching that might be seen to support them in learning Mathematics. In order to achieve the purpose, the following objectives were used:
a) Establish first year undergraduate Mathematics students' experience of learning first year Mathematics course
b) Establish factors that affect how first year undergraduate Mathematics students feel about learning first year mathematics.
c) Investigate first year undergraduate Mathematics students' perceptions on the teaching strategies that might support them in learning Mathematics.

Literature Review
The factors leading to low retention rates need to be understood. Many studies have been carried out to investigate the causes of these variables (Daka, 2019a; Daka & Changwe, 2020; Daka, Banda & Namafe, 2020). However, depending on the setting, the predictors might be different.

It should first be emphasised that upon enrolling into a higher learning institution, students enter environments that have the power to shape their behaviour and influence their success. Many authors (Kakupa, Tembo & Daka, 2017; Daka, Banda & Namafe, 2017; Daka, 2019a) have stated that a welcoming and non-discriminatory climate is critical and needs to be maintained as it creates an environment for quality-learning. Further, some authors have emphasised that comments from lecturers on the achievement of learners are very vital (Daka et al., 2021). Some negative perceptions of lecturers towards learners and comments are barriers to quality learning. Reducing other forms of discrimination is also critical to quality improvement in learning environments. Ulug, Ozden, and Eryilmaz (2011) from their studies showed that that lecturers' positive perceptions towards learners positively influence students' personality as well as their academic performances. This is from the understanding by Karsli (2007) that education is the activity that aids new generations to obtain the necessary information, ability, attitude and understanding and develop their character while preparing them for communal life; and all these are transmitted from the teacher. Karsli (2007) and

Mwamba, Musonda and Daka (2021) also add that the most important factor in education and teaching activities is the teacher's attitude towards teaching.

It has been stated by some authors in medical education that the most contributing factor to students' good performance has been the type of instruction received during the course of learning and the continual evaluation and monitoring of courses (Mulenga-Hagane et al., 2019; Daka et al., 2021). Therefore, from the above authors' views it is important that the type of instruction used by the instructor (lecturer) is evaluated. Other authors echo that student performance is affected by quality of teaching (Wayne & Youngs, 2003; Wilson, 2009).

Daka, Namafe and Katowa-Mukwato (2019) then propose that with situations world over, learning institutions need to re-invent themselves in improving teaching and learning if they wish to maintain high student performance. This entails that learning institutions like the Kwame Nkrumah University should evaluate its learning processes in order to come up with workable strategies which can result into quality of learning to improve the performance in Mathematics by its students.

On the type of methods in teaching mathematics university level, Daka (2019a) argues that learning is an active process and problem-based, or inquiry-based, learning can be used in teaching mathematics. Daka (2019b) and Mwamba et al. (2021) pointed out that most learners especially adults lose interest in an educational experience without the incorporation of active learning. Billings et al (2005) also agrees with the aforementioned authors that active engagement in teaching promotes critical thinking skills and improves long-term retention of content. Cioffi (2001) and Daka et al. (2021) also add that active learning increases motivation and interest in the learning domain.

Most of the scholarly work on teaching and learning indicates that the passive lecture format where faculty do most of the talking and students listen is contrary to almost every principle of an optimal learning environment (Bain, 2005; Daka, 2019b). Rather, active and collaborative learning approaches feature three elements that matter to student learning; involving students, increasing their time on task, and taking advantage of peer influence so that they can interact more.

Active learning or cooperative is any teaching method that gets students actively involved; cooperative learning is one variety of active learning which structures students into groups with defined roles for each student and a task for the group to accomplish (Cejda & Hoover, 2010). Mwamba, Musonda and Daka (2021) added that cooperative teaching techniques involve the students in the class and increase retention of information following the class period.

Kakupa, Tembo and Daka (2015) state that active and collaborative learning is an effective educational practice because students learn more when they are intensely involved in their education and are asked to think about and apply what they are learning in different settings. Daka (2019b) agreed that this practice if implemented might be able to reduce the dropout rates.

Roger (2007) mentions that students arrive at learning experiences with different learning styles. Daka, Namafe and Katowa-Mukwato (2019) added that that students' process learning experiences through visual, auditory, and tactile. These authors further added that if one strategy is used for teaching, other students will be affected negatively and result in low retention rates. Therefore, Allen (2016) proposed that a learner-centred approach requires the instructor to adjust instructional strategies to best meet the needs of their students (Allen, 2016).

Methodology

This study adopted an explanatory sequential design where qualitative data was used to explain quantitative data. Even though the qualitative method shed more light on the quantitative data through the exploration of the research themes, in this study there was no

predominant method as both data sets were very useful in achieving the objectives of the study. The results of both quantitative and qualitative approaches are integrated during the discussion. The target population for this study was 182 students taking Mathematics as one of their first year courses at Kwame Nkrumah University in Central Zambia. Purposive sampling was used in selecting participants in this study. Chipindi, Serenje-Chipindi and Daka (2021) pointed out that the power of purposive sampling lies in selecting information-rich cases which can be used for in-depth analysis related to the central issue being studied which in this case were the students taking mathematics course in their first year. Also Carolyne and Daka (2021) added that this type of sampling is very common for qualitative data as purposive sampling is employed to identify and select strategically, individuals who understand the central phenomenon.

Data was collected via questionnaires, with open and closed questions, semi-structured interviews and document analysis of the past mathematics results. The self-completion survey questionnaire was designed in exactly the same way for each respondent primarily designed to get more objective information than just mere opinions and these were administered by the researchers so as to get higher response rate as Silwamba and Daka (2021) proposed. In this case the response rate for the questionnaires was 94%. The semi – structured interviews were conducted on mathematics lecturers.

Simple descriptive statistics which included among others, measures of central tendency (averages), frequencies and percentages were used in analysing quantitative data. These were first done as stated by Daka (2019a) and Mwamba, Musonda and Daka (2021) that descriptive statistics give the reader a 'picture' of the data collected. Use of research objectives as a guide to analyse different types of data helped the researchers in grouping data of the same theme when analysing qualitative data. This is in agreement with Mulenga-Hagane, Daka, and Kanchebele-Sinyangwe (2020) who pointed out that in qualitative data analysis is best done using research objectives as a guide. Ethical consideration was taken into account throughout the study and clearance was sort from the University.

Findings

The findings were grouped in line with the research objectives. Starting with the first objective was targeted at establishing the experiences that student had with the first year undergraduate Mathematics in learning first year Mathematics course, the respondents from the questionnaires stated how they associated with mathematics. The table below shows the positive and negative words they associated with mathematics.

Table 1. Words associated with first year mathematics course

Positive word		Negative words	
Word	**Frequency**	**Word**	**Frequency**
Confident	6	Fear	80
Enjoy	7	Weak	8
Easy	12	Difficult	38
Interesting	2	Struggle	13
Strong	3	Unconfident	14
Total	**30**	**Total**	**152**

Source: Field data (2019)

From above, the table shows that only 30 (16.5) of the respondents used positive words associated with first year mathematics while 152 representing 83.5% used negative words. This is a clear indication that students viewed first year mathematics negatively.

The second objective of the study was to establish factors that affect how first year undergraduate Mathematics students feel about learning first year mathematics. The following were the responses from the participants and documents analysed depending on the theme.

(a) Students' attitude/beliefs/disposition toward university mathematics

When asked about their attitudes and beliefs toward university mathematics, one of the participant complained and said,

"*My fear is that almost 3 quarters of the people out there have negative attitude towards maths. Even those who are doing it here have told me that it is tough. We also do not have enough teachers*".

(b) Mathematics lecturers' ways of teaching

Students had a say on the way mathematics lecturers teach as compared to other courses. One participants cited "*They are too fast-Rushing through points*".

While another participant added, "*they use only one method of teaching throughout*".

On teaching that brings about understanding, one student complained saying, "*There is lack of in-depth explanation for understanding in all the maths lectures*".

Another participant explained how the mathematics teach as, "*The lecturer talks throughout the lesson while we are asked to be quiet, to listen, to work in silence. We are not allowed or expected to ask questions*".

(c) Mathematics Lecturers' attitude/disposition

On mathematics lecturers' attitude, participants in this student bemoaned the words the lecturers use on learners. One participant highlighted some things like, "*mathematics has become a tough subject in this university because our lecturers do not attend to individual needs of us learners*".

Another one added, "*Students tend to fail because some lecturers intimidate learners to an extent that learners develop a negative attitude maths*".

The above statement from the student participant was in line with what some lecturers stated. One lecturer said, "*I am a lecturer not a secondary school teacher, I am not here to baby sit*". While another mathematics lecturer also added his view saying, "*First year should serve as a process of 'weeding out' unsuitable students who should not be studying Mathematics at university*".

(d) Examination attrition rate

From the documents analysis of the past first year mathematics examination results, the following table showed the examination attrition rates (failure rates) for the stated years.

Table 2. Failures rates

YEAR	PASS	FAIL	TOTAL
2015	172 (59%)	119 (41%)	291
2016	172 (60%)	114 (40%)	286
2017	169 (52%)	159 (48%)	328

Source: Field data (2019)

Table 2 shows that in all the three (3) consecutive years, the examination attrition rates in first year mathematics was 40% and this must raise concerns.

The third and last objective investigated the first year undergraduate Mathematics students' perceptions on the teaching strategies that might support them in learning Mathematics. This objective targeted at getting views on what students thought would help

reduce the examination attrition rates. Participants gave different views on the strategies that might support learning of mathematics. Some of the views were as follows:

One student participant proposed, "*Allow us time and chance to ask questions and discuss within lecturing sessions*". Another one also added, "*Lecturers should use words of encouragement like, 'keep trying until you understand'*. One more summarised it saying, "*Our lecturers should find ways of accommodating student's various learning strategies by providing practice materials*".

One of the mathematics lecturer proposed that if the face of mathematics results is to change for the better, "*Students should be allowed to work/practice or discuss with a partner or in groups within lecturing session though this require more time to be allocated to mathematics*". Another mathematics lecturer added saying, "*We need to ensure that the pace of the lecturing is appropriate to the learning needs of the students*".

In addition, one lecturer gave one view of solving this problem stating, "*while we know that mathematics is mathematics, the way mathematics is taught at secondary level is slightly different from the way it is taught at university level. This may help some students to talk about such with first years as a way of preparing them psychologically and in the transition and settling to learn mathematics at the university.*"

One of the most long serving lecturer in department of mathematics during interviews proposed saying,

"*There are three (3) ways in which lecturers in my department can help reduce the failure rates in maths at first year. These are:*

i. *Try to clearly explain mathematical concepts (Using teaching aids where need be).*
ii. *Try to make connections between different mathematical concepts.*
iii. *Try to make connections between mathematical concepts and real life situations*".

Discussion

The findings in this study revealed that many things contributed to the failure of students in the first year mathematics. One major findings is that students had negative perceptions about first year mathematics. There is need to change the perception of students towards learning of mathematics. In institutions where students view mathematics positively, the academic performance is high. This is in line with some scholars who argued that if the performance is to be high in mathematics, student's personal perceptions related to learning Mathematics at University level must be also high (Hong, 2009; Rylands, & Coady, 2009). For this to work well, the attitude and beliefs of lecturers must be changed so as to motivate the learners to work hard and help them understand that mathematics is manageable. Daka and Changwe (2020) and Daka et al. (2021) advised that motivation from the lecturer can lead students to perform well. There are two major types of motivation namely intrinsic and extrinsic motivation. Intrinsic motivation focuses on the subject. The lecturers are able to encourage students to love the subject and work hard. The extrinsic motivation includes expectation from others and the rewards or punishment of outcome.

In the study, another issue raised was the use of different instructional strategies. This is in agreement with what Turner et al (2017) proposed that differentiated instructional strategies should be considered when you want to raise the academic performance of students at university level. The major theoretical contributions to understanding the student attrition process have relied heavily on approaches used in teaching as well as socialization with the college environment (Wilson, 2015). In this vein, some researchers have shown that constructivist approach forms the basis of learner-centred instructional methodologies that are relevant and meaningful for students (Allen, 2016). Differentiated instruction is argued to be working at primary and secondary school (Daka, 2019b) and so it could work at tertiary level. Many researchers have echoed that the proper used visual aid and the point of instruction make

deep impression that learners can recall the concepts for many years to come (Zhao & Cziko, 2011; Mwamba et al., 2021; Daka, Chipindi, & Mwale, 2020; Daka, Namafe, & Katowa-Mukwato, 2019). In addition, Lamon (2012), Daka, Banda and Namafe, (2017) and Kakupa, Tembo and Daka (2015) highlight instructional strategies as a major contributor to students' good academic performance. It is stipulated in their study that an effective educator would have a wide array of instructional strategies at their disposal and know when specific strategies are to be used for specific students and specific content.

Findings from the past examination results showed that the examination attrition rates were 40% and above. These results needed an explanation. This is in agreement with Tyre-Smith (2010) who posits that if the examination attrition rates are more than 10%, there is need for investigation in order to come up with strategies of improving quality of education thus the reason this study was conducted.

Conclusion

From the findings, it can be concluded that there are a lot of challenges that students who take first year mathematics face. These are ranges from the negative lecturer's characteristics and perceptions of teaching Mathematics at University level, student's personal perceptions related to learning Mathematics at University level, few contact hours with the students and the type of methods used in teaching. In addressing these challenges, the study proposed some recommendations and possible measures to mitigate the high failure rates of students in the first year mathematics. Some possible measures proposed include the following:

i.   Recruiting qualified tutors to help students in tutorials when they are in small groups thereby increasing contact hours for first year mathematics.
ii. Encouraging lecturers to change their perceptions and attitude towards the teaching of mathematics so that they should be motivating learners.
iii. Demystifying the perception that mathematics is a killer course and that many fail among the first years.
iv. Training lecturers who teach mathematics in modes of teaching that could support them in learning Mathematics and overcoming fear in the students.

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