In this study I investigated the perceptions of first year mathematics students towards an alternative mode of delivery intervention programme at the University of Namibia. The alternative mode intervention programme implements a slower pace of teaching, accommodating student needs and background gaps. Lecturers developed specific teaching strategies that afforded students individual attention, greater interaction, mediation and tutorial sessions. I report on the students’ and lecturers’ responses to focus group discussions and interviews respectively. Students identified that mathematical proficiency was central to their learning, and pedagogical knowledge and exploratory talk were critical aspects of good teaching in a mathematical intervention programme.

Introduction
According to the University of Namibia (UNAM) Science Faculty (2010), the first year of study of Mathematics at University of Namibia has been problematic for the past 10 years. The majority of the students are unable to cope with the first year modules in Mathematics, and as a result the pass rates are unacceptably low. Many students fail these modules even after repeating them. The main reasons attributed to the poor performance are seen as a flawed high school curriculum, the lack of teaching aids, and poorly qualified teachers at high schools. As a result, the mathematical content required for first year mathematics was not adequately taught in high school.

Historically, a number of attempts have been made to overcome this shortcoming, but none has yielded improved performance. The University of Namibia Science Faculty was thus prompted to introduce a two-mode intervention programme in first year Mathematics, namely the normal...
mode and the alternative mode intervention. The alternative mode intervention was designed to improve the Mathematics achievement of first year students who are considered low achieving or at risk of failure. The first year Mathematics students on the alternative mode of delivery intervention are enrolled for the B.Sc. or B.Ed. Honours degrees. For some students, Mathematics is a prerequisite subject in the course, however for others Mathematics is not. According to the UNAM Science Faculty (2010), as from 2011, all students who register in the faculty of Science sit for the first class test in Mathematics which is held after four weeks of teaching. Those who score a mark of at least 40% will be admitted to the three standard first year Mathematics modules. Those who score a mark of less than 40% are admitted to the alternate mode intervention programme.

This study aims to understand, inform and to ultimately contribute to, effective insights into the learning of Mathematics in the alternative mode intervention programme. In addition, it may possibly inform other constructive interventions in higher Mathematics education. The research project was conducted at the main campus of the University of Namibia, in Windhoek. The researcher is a high school Mathematics teacher and a former student at UNAM.

**Aim of the research**

The aim of this research was to investigate the influence of the alternative mode of delivery on students’ learning and development of mathematical proficiency. This involved developing an understanding of how the teaching and learning context of the alternative mode intervention programme supported effective student learning. The focus was on the experiences of the individuals who formed part of the intervention programme and the meaningful insights they gained of their learning experiences. The following specific research questions were posed.

1. What are the experiences of first year Mathematics students in the alternative mode of delivery?
2. What influence does the alternative mode of delivery have on the student learning experience?
3. How does this student learning experience influence their development of mathematical proficiency?
4. What are the potentials of the alternative mode intervention as a vehicle for first year Mathematics teaching?
Literature review

Many university students find themselves mathematically underprepared for their chosen field of study. Godden and Pegg (2003) identified three reasons for this: firstly, the mathematical skills of the students are deficient; secondly, the depth of their exposure to various mathematical topics is limited; and thirdly, there is an increasing reliance on mathematical techniques and concepts in subjects and courses not traditionally mathematically orientated. In addition, the gap between school and university Mathematics seems to be larger than in other subjects (Tall, 1991). Gordon and Nicholas (2011) state that the challenges of teaching an increasingly diverse cohort in higher education are felt in every discipline, but arguably more so in Mathematics.

Gordon and Nicholas (2012) state that the transition from secondary education to tertiary education is an area of particular research interest. Leviatan (2008) conjectured that there is a distinct cultural gap between school Mathematics and tertiary Mathematics. Many first year college students find it difficult to adapt to a culture where concepts are abstract, yet require rigorous definitions, and where theorems have to be proved and their assumptions meticulously verified before their results can be applied (Leviatan, 2008). According to Jennings (2009) numerous universities are investigating the problem and trying to improve this transition. Varsavsky (2010) argues that in order to attract more students to Mathematics and mathematics-based disciplines, and to improve retention, universities have been addressing the under-preparedness in Mathematics of their incoming students with bridging or remediation programmes and, more generally, with programmes that support the student transition from secondary school to university Mathematics study. Bryant, Bryant, Gersten, Scammamca and Chavez (2008) stipulated that without early identification, intervention and progress monitoring to determine students’ response to interventions, many students with mathematics difficulties may not develop a level of mathematics automaticity that is necessary for becoming proficient in Mathematics.

Knowing how to teach Mathematics well to students with differing abilities seems to be much more important than having Mathematics teachers who possess a strong background in Mathematics (Ball, Lubienski & Newborn, as cited in Baker, Gersten & Lee 2002, p. 56). Instructors need to have a vast repertoire of effective lecturing methods on hand (Jungic, Kent & Menz, 2006). A synthesis of empirical research
on the teaching of Mathematics by Baker, et al. (2002) adds that using peers as tutors or guides may enhance achievement. The use of peers to provide feedback and support improves low achievers’ computational abilities and holds promise as a means to enhance problem-solving abilities (Baker, et al., 2002).

The findings of a study by de Caprarriis, Barman and Magee (as cited in Carpenter, 2006) suggest that lecturing leads to the ability to recall facts, while discussion produces higher level comprehension. Effective teaching can be achieved by preparing typed lecture notes for students in advance and then using time efficiently in a large class (Jungic, et al., 2006). In contrast, in this research which examined perceptions across six teaching methods (lecture/discussion, lab work, in-class exercises, guest speakers, applied projects, and oral presentations), most students preferred the lecture/discussion method (Jungic, et al., 2006). In terms of students’ preferences for teaching methods, a study by Samson, Sewry and Southwood (2011) suggests that students preferred team teaching methods. Having two lecturers with different but complementary styles was cited as strengthening the class’s overall confidence towards the subject.

Kilpatrick, Swafford and Findell (2001) suggested that teachers should play a more active instructional role in helping students build mathematical proficiency than they currently do. Kilpatrick, et al. (2001) formulated the concept of mathematical proficiency to capture all aspects of expertise, competence, knowledge, and facility in Mathematics which they believe are necessary for anyone to learn Mathematics successfully. Mathematical proficiency consists of five components or strands and these strands are not independent, but rather are interwoven and interdependent. For this reason, mathematical proficiency is not a one-dimensional trait, and it cannot be achieved by focusing on just one or two of these strands. The strands of mathematical proficiency are:

- **Conceptual understanding** – relating to a comprehension of mathematical concepts, operations, and relations.
- **Procedural fluency** – referring to knowing, selecting and performing calculations and procedures or skills.
- **Strategic competence** – referring to the ability to formulate, represent, and solve mathematical problems.
- **Adaptive reasoning** – referring to the capacity for logical thought, reflection, explanation, and justification.
- **Productive disposition** – referring to a habitual inclination to see
Mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy.

(Kilpatrick, et al., 2001, p. 5)

Kilpatrick, et al. (2001) remark that the teaching and learning of Mathematics is the product of interactions among the teacher, the students, and the mathematics. This is illustrated in the instructional triangle, shown in Figure 1. If students are to develop the capacity of high-level thinking in a variety of academic domains, then classrooms must become environments in which they have frequent opportunities to engage in dynamic mathematical activity that is grounded in rich, worthwhile mathematical tasks (Schoenfeld, 1994).

Figure 1: Instructional triangle

Instruction can best be examined from the perspective of how teachers and students interact with content in contexts to produce teaching and learning (Kilpatrick, et al., 2001). The tasks in which students engage
provide the contexts in which they learn to think about subject matter (Stein & Henningsen, 1997).

Wegerif and Mercer (1997) chronicle their definition of exploratory talk from the outcome of the SLANT (Spoken Language and New Technology) project, which observed children engaged in computer-based joint activities in 12 British primary schools (as described in Mercer, 1995). Mercer (1995) defines exploratory talk as follows:

> Exploratory talk is that in which partners engage critically but constructively with each other’s ideas. Statements and suggestions are sought and offered for joint consideration. These may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered. In exploratory talk, knowledge is made publicly accountable and reasoning is visible in the talk.

(p. 25)

Wegerif and Mercer (1997) used the terms ‘logical’, ‘rational’ or ‘reasonable’ to describe a person who could make appropriate, clear and useful contributions to discussions, in ways that enabled solutions to shared problems to be achieved.

### Methodology

The research investigation was conducted in three different phases. Firstly, 50 students completed a questionnaire. Secondly, focus group discussions were held with 12 volunteer students. Thirdly, interviews were conducted with 6 lecturers who were teaching on the intervention programme. The data collection for the second and third phases was through interviews, focus group discussions and lecturer interviews. The author used a phenomenographic approach for data analysis as this method allows for the discovery of different qualitative categories of descriptions (Morton & Booth, 1997).

The University of Namibia ethics committee approved the study and all participants gave their written consent.

### Findings and discussion

The mode structure appeared to have an impact on student learning. Figure 2 shows how the students’ experience on the programme influenced their learning experience and how this impacted on their development of proficiency.
Students enjoyed and appreciated the tutorial sessions, and group work was an important aspect of this programme. Students reported that they appreciated working with other students in collaborative small groups in mathematical learning. More rules and justification of one’s work were explored, which led to more reasoning. Group work improved students’ ways of thinking and ways of understanding. Students were comfortable when asking questions and for clarification about mathematical problems with friends as the need arose. Exploratory talk enabled students to justify their opinions, and this led to adaptive reasoning. One student captured the benefits of collaborative small groups when he stated that:
I find Tutorial sessions beneficial to me as we get to interact with other students and justify our answers. Problems were solved quicker. It’s more convenient and comfortable solving mathematical problems with friends. In tutorials we are free to ask further questions and clarifications as need arises.

(FG1: Sacky, Line 5)

The intervention programme implemented a slower pace of mathematics teaching. The majority of students found the content and pace of the basic Mathematics module to be ‘just right’. The module was designed with a moderate introduction period to build student confidence, morale and help alleviate some students’ phobias about Mathematics. Students enjoyed this because they had more time to focus on other mathematics modules and other subjects. One student concurred that the mathematics intervention promoted self-development by saying “Being on the intervention programme, I have gained self-confidence and all motivation needed to go through this programme. This gave me extra motivation to work harder than before. I hope this will work forever” (FG2: Keith, Line 48).

The slower pace of mathematics teaching reduced students’ anxiety about their mathematics learning. Students also appreciated the extra feedback. The lecturers could explain a wider variety of mathematical problems and had more time to answer questions. Students became more confident in their learning, believing that the results in their Mathematics tests, assignments and examinations were testament to the quality of the teaching. This gave them the confidence to believe that they could compete favourably with other students on the standard mode. They changed their perceptions of what they could actually achieve: their worries changed from whether they would pass assignments and tests, or qualify to sit exams, to how well they would perform.

Different teaching approaches were explored in the alternative mode and students had the flexibility of selecting lectures of their choice. The use of an interactive whiteboard enhanced lectures, making them more visual, understandable and interactive. It was found that showing a single Mathematics concept symbolically, numerically and visually could lead to improved disposition. Also, student interaction through the use of the interactive whiteboard was improved because the board offered space that allowed students to engage in active collaboration. Finally, lecturers could present material featuring large, vibrant images.
The applications to statistics, engineering and other science courses were found to be particularly useful in aiding understanding. Students could recognize and expand the importance of mathematics within statistics, engineering and other science courses and in this way gained an appreciation of the direct relevance of the topics studied. This helped to create enthusiasm and interest in solving mathematical problems.

Conclusion

It was found in this research that the mathematics intervention programme did indeed bridge the gap in the mathematics content taught, and this enabled students to build a strong foundation in university mathematics. In addition, the mathematics intervention programme reduced students’ anxiety about mathematics learning. Tools used in this intervention programme included an interactive whiteboard which provided strong visual representation that led to improved visualization, student engagement and agency. The small group sessions were seen as important and powerful for enabling learning. Students were open to working in collaborative small groups. Group work enhanced exploratory talk which in turn led to improving students’ adaptive reasoning. Finally, the team teaching strategy advanced the level of interaction between students and lecturers as well as between the students themselves.

REFERENCES


UNAM Science Faculty (2010). Submission: Two modes in first year modules of mathematics. PGCE research report, University of Namibia, Science Faculty, Windhoek.
