THE USE OF CONSTRUCTIVISM IN TEACHING MATHEMATICS FOR UNDERSTANDING: A STUDY OF THE CHALLENGES THAT HINDER EFFECTIVE TEACHING OF MATHEMATICS FOR UNDERSTANDING IN SENIOR SECONDARY SCHOOLS IN THE OMUSATI EDUCATION REGION

MASTERS OF EDUCATION

TOBIAS AMOONGA

FEBRUARY 2008

THE USE OF CONSTRUCTIVISM IN TEACHING MATHEMATICS FOR UNDERSTANDING: A STUDY OF THE CHALLENGES THAT HINDER EFFECTIVE TEACHING OF MATHEMATICS FOR UNDERSTANDING IN

SENIOR SECONDARY SCHOOLS IN THE OMUSATI EDUCATION REGION

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF EDUCATION

OF

THE UNIVERSITY OF NAMIBIA

BY

TOBIAS AMOONGA

FEBRUARY 2008

MAIN SUPERVISOR: PROF C. KASANDA

CO-SUPERVISOR: DR D. ZEALAND

APPROVAL PAGE

This Research Project has been examined and is approved as meeting the required standards for the partial fulfillment of the requirements of the degree of the Masters of Education.

1. _____ _____

Internal Examiner Date

2. _____ _____

Internal Examiner Date

3. _____ _____

Dean of Faculty Date

4. _____ _____

External Examiner Date

DECLARATIONS

I, Tobias Amoonga, hereby declare that this study is a true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education.

Signature: _____ _____

Tobias Amoonga Date

COPYRIGHT

Signature: _____ _____

Tobias Amoonga Date

DEDICATIONS

This Thesis is dedicated to my parents, Lazarus Amoonga and Aune Nambundunga, who brought me up in an environment of hardwork, shaped my aspirations towards maintaining the highest moral standards, and created opportunities for me to attend school throughout my entire career despite financial hardship. I salute them.

ACKNOWLEDGEMENTS

I wish to extend my whole hearted thanks and appreciation to various people who contributed enormously to the success of this thesis.

First of all I would like to express my sincere thanks to Professor McCracken, at Harvard University for first introducing me to the concept of Teaching for Understanding in 2001. She probably did not think I was listening. Six years have passed since then. But I have never forgotten her prophetic words, “teaching for understanding makes learning thinking centered”.

Special gratitude is due to my supervisors, Professor C. D. Kasanda & Dr. D. Zealand for their guidance that led me to produce a scholarly thesis. They made themselves available for me and secure space for my consultations in their tight daily schedules including weekends and after hours. I thank you very much.

A lot of credit should go to United Nations Educational, Scientific and Cultural Organization (UNESCO), Windhoek Cluster Office, for financial assistance towards this study. UNESCO has made the destiny of this project a reality.

I am also grateful to my entire family and friends for being patient when I was not available for them during this study. Thanks to my wife, Martha Ndapandula Amoonga, my son Twapewa Amoonga, my daughter Aune Amoonga and my sister Nyanyukwa Amoonga for their moral support and endless encouragement. I love you all.

My sincere gratitude and thanks are due to the Director of Omusati Education Region Mr. Lamek Kafidi for grating me permission to conduct this study in his Education Region. The school principals of the selected schools in Omusati Education Region who warmly welcomed me to their respective schools deserve mention. Without them I could not have administered the designed instruments, which have been the key to my current achievement.

My heartfelt thanks and gratitude goes to the teachers from the selected schools in the Omusati Education Region who actively participated in this study. I thank you all for being part and parcel of this study despite your tight schedules.

Last but not least, thanks to Mr. Kadhila Ngepathimo for his support, and to the great typist, Sylvia Goagoses.

LIST OF ACRONYMS

BETD	Basic Education Teacher Diploma
DNEA	Directorate of National Examinations and Assessments
ERA	Education Report Advisory
ETSIP	Education and Training Sector Improvement Programme
HIGCSE	Higher International General Certificate of Secondary Education
IGCSE	International General Certificate of Secondary Education
INSTANT	In-Service Training and Assistance for Namibian Teachers
LCE	Learner Centred Education
MBESC	Ministry of Basic Education Sport and Culture
MEC	Ministry of Education and Culture
MOE	Ministry of Education
MHETEC	Ministry of Higher Education, Training and Employment Creation
NAMSTA	Namibian Mathematics and Science Teachers Association
NCTM	National Council of Teachers of Mathematics
NDP2	Second National Development Plan
NIED	National Institute for Educational Development
UNAM	University of Namibia
UNESCO	United Nations Educational, Scientific and Cultural Organization

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

ABSTRACT

The major purpose of this study was to investigate factors and challenges that hindered effective teaching of mathematics for understanding in senior secondary schools in the Omusati Education Region. The study investigated the way teaching mathematics for understanding approaches were applied in the teaching of mathematics classrooms in selected senior secondary schools. Further, the study attempted to establish necessary support and / or training opportunities that mathematics teachers might need to ensure effective application of teaching mathematics for understanding in their regular classrooms.

The sample was made up of eight senior secondary schools out of the population of 12 senior secondary schools in the Omusati Education Region. The schools were selected from the school circuits using maximum variation and random sampling techniques. Twenty out of 32 mathematics teachers from eight selected senior secondary schools in the Omusati Education Region responded to the interviews and two lessons per participant were observed.

Interviews and observations were used to collect data from the 20 senior secondary school mathematics teachers with respect to teaching mathematics for understanding. Frequency tables, pie charts and bar graphs were used to analyze the data collected.

The results indicated that most, 11 (55%) of the mathematics teachers did not have adequate knowledge about teaching for understanding. The data also indicated that teaching for understanding was little observed in mathematics classrooms. Part of the challenges identified were, overcrowded classrooms, lack of teaching and learning resources, lack of support from advisory teachers, and automatic promotions, among others. Mathematics teachers needed induction programmes, in-service training opportunities, and advisory services amongst others in order to be able to teach mathematics effectively.

The study recommended that teaching for understanding should be researched in all subjects in Namibian classrooms and should be made clearly understood by all teachers in order to be able to use and apply it during their teaching. New teachers should be provided with induction programmes to give them support and tools at the beginning of their teaching careers. Further research on teaching for understanding should be conducted in other school subjects in Namibia in order to ensure teaching for understanding across the curriculum.

CHAPTER 1

INTRODUCTION

Background of the study

Namibia inherited a segregated education system from the previous colonial government. As described by the Ministry of Education and Culture (MEC, 1993), policies of racial discrimination have left a legacy of differential allocation of resources to different racial groups. Like many other post-independent African countries, Namibia went through many changes after independence, politically, socially and educationally to determine its own destiny. The Ministry of Education and Culture (1993) articulated the four major goals of education as access, equity, quality and democracy. MEC (1993:74) noted, "As we make transition from educating the elite to education for all we also make a shift from teacher centred to constructivism."

For the Ministry to achieve these goals, several strategic initiatives were launched. Amongst others, a new Senior Secondary School Program leading to the International General Certificate of Secondary Education (IGCSE) and the Higher International General Certificate of Secondary Education (HIGCSE) were introduced in 1994 to replace the South African Cape Education System. The new programmes (HIGCSE and IGCSE) were launched to prepare students for entry to the University of Namibia and other tertiary institutions (MEC, 1993).

Education reform in independent Namibia was necessary for many reasons. According to MEC (1993) and MBESC (1996) for instance, the Cape Education System had a number of discrepancies. First, it was inefficient in terms of low progression and achievement rates (MEC, 1993; MBESC, 1996). Examinations were typically discriminatory, i.e., norm-referenced, rather than criterion-referenced (MBESC, 1996). Second, the Cape Education System was found to be irrelevant to the needs of the indigenous Namibian people. It was fragmented and segregated on the basis of racial and ethnic background. Third, it was characterized by unequal access to education and training at all levels of the education system. Fourth, it was teacher-centred and was characterized by poor classroom practice, low learner participation and poor learner performance, that could not be relied upon to promote quality education as it was based on rote learning and memorization rather than understanding (Cohen, 1994). Fifth, MEC (1993) and MBESC (1996) further claimed that the curriculum and teacher education programmes of the Cape Education System were irrelevant to the needs of individual teachers in Namibia to meet the demands of teaching for understanding.

It is against the above historical education background, that the Cape Education System was abolished in Namibia shortly after independence and replaced with the (H)IGCSE system. According to MEC (1993:7), "the IGCSE and HIGCSE were therefore seen as an internationally accepted examination addressing the shortcomings of the Matriculation Examination." The introduction of the HIGCSE and the IGCSE raised fears, doubts and questions in many of the teachers on how they would best provide effective instruction to their students. In the same vein, the HIGCSE and IGCSE imposed many challenges on

the Namibian educators to re-think how education should be approached to realize the broader goals of access, equity, quality, democracy, efficiency and life-long learning as stipulated in the national guiding policy document, "Towards Education for All" (MEC, 1993).

During the Cape Education System, the teaching practice was informed by the view that learners were empty vessels that needed to be filled by the teacher. In other words learners were viewed as passive recipients of knowledge, blank sheets on which the teacher can write. The teachers were regarded as the centre of learning and all knowing and had to supply knowledge to the students (MBESC, 1996). It is against this background that the Ministry of Education and Culture proposed the learner-centred (LCE) teaching methods for Basic Education in Namibia. Schrenko (1994) notes that in a LCE approach the learner must be at the centre of the teaching and learning processes, where learners' interests and needs should be taken into account when a teacher is planning or presenting a lesson.

The LCE promotes active learner participation and encourages self discovery and understanding in learning. The Ministry of Education and Culture (1993) describes active participation as a high degree of interaction and involvement of learners in the instructional process of learning for understanding. The Ministry goes on to indicate that by active participation learners should feel involved, make contributions, ask questions, formulate concepts, find evidence and examples (MEC, 1993).

Freire (1998) states that most Brazilian teachers are still not bothered to find out whether the learners understood what is being taught or not. Freire indicated that LCE should be build on reflective teaching and understanding in order to facilitate learners making connections between classroom activities and real life experiences. The LCE methods to be used in the Namibian classrooms should therefore encourage teachers to teach for understanding in order to help their students to make connections between what they learn in school and what they do outside of school.

According to Blythe (1998) nurturing understanding is one of the loftiest aspirations of education and also one of the most elusive. Blythe further suggest that good answers to the question, "What is understanding?" are not obvious. Consider the difference between understanding and knowing. "When a student knows something, he or she can bring it forth on demand, tell us the knowledge or demonstrate the skill. But suppose the student can find examples of the lesson at home in everyday experiences; one would say that the student developed an understanding of the lesson" (Blythe 1998:12). Teaching for understanding is exhibited in the following ways:

- Mathematics teachers are expected to play a greater role as "coaches" for their students learning in order to help students to think with and about the ideas they [students] are learning by making learning a long-term thinking-centred process.
- Teachers are expected to provide for rich ongoing assessment that fosters understanding rather than simply evaluating students at the end of the unit.

- Classroom environment is expected to be supported by learning with powerful representations that will help students to solve problems that ask them to apply new ideas in unexpected ways.
- The teacher is expected to use verbs like explain, find evidence, derive formulas, generalize, represent the topic in new ways, suggest, etc, in the lesson objectives.
- Students are expected to participate actively in the learning process through interactions with others, application of experience from home, and engagement in thought provoking activities.

Theoretical framework

Teaching for understanding is an effective classroom instruction theory inspired by constructivism. It has a long-standing history in psychology, anthropology, as well as cognitive psychology and education (Blythe, 1994). The first philosopher who developed the theory of Constructivism was Giambatista Vico in 1910 (Yager, 1991, cited in Blythe, 1994). The teaching for understanding was derived from Jean Piaget's theory of socio-moral and cognitive development (Blythe, 1994). Other philosophers that contributed to the teaching for understanding framework include Dewey, Brunner, Ausubel and Vygostsky, just to mention but a few. Piaget's theory of cognitive development has dominated the views of educators for several decades now on how children learn. The teaching for understanding framework was developed further in a research project called Project Zero during the early 90s headed by The National Council of Teachers of Mathematics (NCTM) (Perkins, 1998).

Teaching for understanding requires teachers to educate students to exhibit what they know and what they can do with what they know in a real time dimension. To teach for performance is to believe in the capacity of students to create, to construct knowledge and to assign meaning to what they have learnt and experienced (Kickbusch, 2000). The ideas, which are central to an education that defines competence as the ability of the student to apply knowledge and skills to unfamiliar problems, are not new. These ideas were found in traditional apprenticeship programmes, were implicit in settings where daughters and sons learnt life sustaining skills from parents, and they were central to the success of all traditional peoples (Berger and Luckmann, 1996).

Constructivist theory provides a framework through which the emergent ideas about teaching, learning, and assessment can be unified. McLaughlin & Rowan (1993:47) summarize both the critique of American public schools as well as the goals of constructivist teaching, as follows:

> The constructivist view of effective classroom instruction is often called 'teaching for understanding' and research on this topic has become a priority for educational policy makers. The importance of this form of teaching lies in its potential to enhance the kinds of cognitive outcomes for students that American educational system has heretofore been notoriously ineffective at producing. While American schools have been relatively successful in engendering basic skills achievement, they have not done well in promoting students' success in tasks variously described as problem solving, critical analysis, higher-order thinking, or flexible understanding of academic subject matter-learning outcomes associated with teaching for understanding.

The same writers explain in the teaching for understanding theory that the difficulty and challenge confronting classroom professionals is that the reform strategies in curriculum instruction and assessment organized around the theory of "constructivism" are informed

by different assumptions and beliefs about the nature of knowledge and the human capacity to learn, unlike perhaps traditional classroom practices. Walter, Meredith & Joyce (1996) indicated that learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation. In other words, constructivist thinkers believe that the most important factor influencing learning is what the learners already know. In order to learn meaningfully, individuals must choose to relate new knowledge to relevant concepts and propositions they already know (Tiberghien, 2000).

In further support of the importance of teaching for understanding, Kickbusch (2000:11) states "that constructivism is not merely an add-on or fad; teaching for understanding strategies are rooted in new beliefs about teaching and learning." Kickbusch (2000:15) goes on to say that "teachers educated in an era of behaviourism, taught during times when coverage of the text was valued, and whose students demonstrated competence on standardized tests, now experience considerable professional dissonance." For example, the belief systems that support mathematics as thinking and reasoning are fundamentally different. Therefore, it is unlikely that teaching for understanding will occur with the occasional use of hands-on-activities or cooperative learning strategies if the teacher's belief system has not changed. A successful educational reform is dependent on professional understanding, consent, and advocacy (Berger & Luckmann, 1966).

According to Berger & Luckmann (1966), the authority of a textbook, a film, a news story, or an expert's interpretation of an event is seldom subjected to critical scrutiny.

Often the skills necessary to engage in such scrutiny are neglected as well. Students tend to emerge from the schools with unstated assumptions; they tend to view themselves as products of and not producers of knowledge and institutions (Kickbusch, 2000). Kinchloe & Steinberger (1993:301) put the social construction of reality into educational terms as follows:

> The frontier where the information of the discipline intersects with the understandings and experiences that those individuals carry with them to school is the point where knowledge is created (constructed). The … teacher facilitates this interaction, helping students to reinterpret their lives and uncover new talents as a result of their encounter with school knowledge.

In further support of teaching for understanding framework Kinchloe & Steinberger (1993) note that researchers on teaching for understanding indicate the vital role the teacher plays in stimulating student learning. This study recognizes that students do not merely passively receive or copy input from teachers, but instead actively mediate it by trying to make sense of it and relate it to what they already know (or think they know) about the topic. Students develop new knowledge through a process of active construction. In order to get beyond rote memorisation and achieve true understanding, students need to develop and integrate a network of associations linking new inputs to pre-existing knowledge and beliefs anchored in concrete experience. Thus, teaching involves inducing conceptual change in students, not infusing knowledge into a vacuum (Steinberger, 1994). It was against this background that this study was carried out. Particularly, it sought to find out challenges that hinder effective teaching of mathematics for understanding in the senior secondary schools in the Omusati Education Region.

Statement of the problem

Given the above background there is evidence that many teachers in Namibia still do not observe a framework that lays out the essential ideas involved in teaching mathematics for understanding (MBESC, 1996). Many teachers do not employ ideas of how to make understanding a more central and reachable goal in their classrooms. Many teachers do not use examples, questions and activities that draw on the teaching for understanding framework. Teachers need support and / or training to ensure effective application of teaching mathematics for understanding strategies. It is against this background that this study sought to find out the factors as well as the challenges that influence the effective teaching and learning of mathematics for understanding in senior secondary schools in the Omusati Education Region.

Objectives of the study

The main objectives of the research were to:

1) Find out the mathematics teachers' understanding and use of teaching for understanding approaches.
2) Find out the extent to which the mathematics teachers practice the teaching for understanding approaches in their teaching.
3) Find out how the schools in which teachers work and class-work activities, tests, assignments, examinations, etc., for which teachers prepare their students, best support learning mathematics for understanding.

4) Identify factors and challenges encountered by grade 11 and 12 mathematics teachers in the application of teaching for understanding framework and how to overcome these challenges.
5) Explore possibilities for support and /or training opportunities that mathematics teachers may need to ensure effective application of teaching for understanding in their regular classroom.

Significance of the study

Many Namibian teachers do not employ ideas of how to make understanding a more central and reachable goal in their classrooms. According to Freire (1998) teachers do not use examples, questions and activities that draw on the teaching for understanding framework. It is hoped that the results of this study would benefit the mathematics teachers on how to help students make sense of what they are learning in the context of the working world. Perkins (1998) suggests that teaching for understanding is a basic skill needed by today's teachers. It has become the means to connect content and application in a learning environment for basic skills as well as their application in various contexts.

It is further hoped that the results of this study would be used by some teachers to improve their own teaching practices, teaching approaches, as well as setting of assessment tasks that would support teaching and learning for understanding. Such information might also be useful to teacher educators at Colleges of Education to coach student teachers on how to teach mathematics for understanding. Information generated

might also be useful to curriculum planners at Teacher Resource Centres during mathematics teachers' training workshops to enhance effective mathematics teaching in Namibia.

The findings and recommendations from this study could have several benefits for school teachers, school principals, school inspectors and material developers who wish to base their teaching materials on the teaching for understanding. In the same vein, the information might be useful to teacher educators to integrate teaching mathematics for understanding in the curriculum. Finally, the research findings of this study could further be helpful to other researchers to carryout more research on how to teach for understanding.

Assumptions of the study

Assumptions are statements of what the researcher assumes to be factors but can not be verified (Perkins, 1988). The following assumptions were assumed to be factors that hinder effective teaching of mathematics for understanding in senior secondary schools in the Omusati Education Region.

1. Teaching/learning activities for which the teachers prepare their learners might not offer necessary support for teaching for understanding. Consequently, the teachers might not be able to provide mathematics content that is worth understanding if the prepared activities cannot create opportunities for students to make sense of what they are doing and/or can not make connections between what they know and what is being presented.

2. It was assumed that teacher education programmes might not be doing enough to equip student teachers with basic competencies and necessary skills that they may need to enable them cope with the very challenging and demanding approaches of teaching for understanding. In addition to this, many teachers in Namibian secondary schools and in the Omusati Education Region in particular might not know and understand how the teaching for understanding works, hence, they might not incorporate it, in their teaching.

3. It was also assumed that essential materials such as textbooks and syllabi, school rules, overcrowded classrooms and lack of facilities might make it difficult and inconvenient for teachers to incorporate teaching for understanding in their teaching effectively. Most of the school principals, advisory teachers, heads of department, circuit inspectors and other school management members might not have enough skills about teaching for understanding (Uzat, 1998). As a result teachers might not be motivated, while very large classes might make it very difficult for teachers to plan activities that support understanding.

4. It was further assumed that some schools might not have sufficient learning resources such as laboratories and libraries to support teaching and learning for understanding. The length of the teaching period per lesson of 40 minutes might be too short since teaching mathematics for understanding requires ample time to teach effectively.

5. It was assumed further that teachers' perceptions that mathematics is a difficult subject might make it difficult for teachers to engage their students in meaningful learning.

Since mathematics is an abstract subject by nature, teaching for understanding could only be realized if both teachers and students alike are prepared to share both commitment and responsibility to teach and learn for understanding.

6. It was assumed that teachers might be influenced by the traditional teaching method that could make some teachers feel uncomfortable with the more demanding reflective and challenging teaching for understanding. Consequently teachers might feel that experience was sufficient to improve their teaching mathematics for understanding.

Limitations of the study

The study was based on the use of the teaching mathematics for understanding framework by teachers in selected secondary schools in the Omusati Education Region only. This was due to limited time and financial constraints. The time that was available at the researcher's disposal was limited to cover all the 13 education regions in the country. Based on the limitations, generalizations of the study findings were limited to Omusati Education Region only as conditions and situations might be different in other regions in the country. Furthermore, this study was not fully funded by any sponsor or organization, as a result, there were no funds available that would make it possible to extend the study to other education regions.

Another limitation was the type of instruments that were used to collect information, i.e., observation and interview. Observation which was used by the researcher has some limitations as it tends to change the situation being observed as well as the element of

research bias attached to it (Brooks and Brooks, 1999). In this case teachers that were observed might have changed their normal behaviour patterns just to impress the researcher and in an effort to eliminate these weaknesses, observation was repeated for two to three consecutive lessons.

Delimitations of the study

Delimitations are the boundaries, within which the researchers would like to place their study. Blythe (1998) pointed out that, understanding is a matter of being able to do a variety of thought-provoking things with a topic, such as explaining, finding evidence and examples, generalizing, applying, organizing and representing the topic in new ways. If the student can find an example of Newtonian physics at work in everyday experiences, is able to see the mathematics logic of the Pythagorean Theorem at home, etc., then, one would be able to say that the student has developed an understanding.

Blythe showed that teaching for understanding can be applied to all areas of the curriculum such as language, science, mathematics, social studies, arts and others. According to Jean Piaget cited in Wiske (2005), teaching for understanding is applicable to all phases of education, from early childhood up to tertiary level. However this study was limited to the use of teaching mathematics for understanding by mathematics teachers at selected secondary schools in the Omusati Education Region. Only mathematics was included in the study as a subject because of persistent poor students'

performance in mathematics over the years compared to other subjects since the introduction of the (H)IGCSE system in 1994.

Definition of terms

Terms may have different meanings in different contexts. In this study the following terms will have the following meanings:

Teaching for understanding approaches.

These will refer to teaching approaches that apply understanding principles. They include learning by doing, learning through enquiry, finding evidence, applying, generalizing, and representing the topic in new ways or lesson objectives that employ verbs such as deduce, determine, suggest, compare, analyze, etc. (Perkins, 1998 ; 2002).

Teaching for understanding

Blythe (1998) defines teaching for understanding as the framework wherein those who are learning are facilitated in their connecting what is learnt in the real world in order to assist learners in making connections between lesson and life.

School cluster

A school cluster is a group of schools that are geographically close and accessible to each other. These schools are grouped to support each other in terms of management and teaching practices (MBESC, 1996).

Cluster centre

The centre (usually a school) that is responsible for running administrative affairs of a group of schools in that particular cluster (MBESC, 1996).

Understanding goals

Understanding goals describes what we want students to get out of their work within a particular topic (Perkins, 1998).

Ongoing assessment

Ongoing assessment is a process of providing students with clear responses and feedback to their performances of understanding in a way that will help them improve the next performance (Perkins, 1996).

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

The literature review consists of short summaries of what is already known and what is still unknown and untested by previous researchers about the research problem (Best & Khan, 1998). This chapter deals with the review of related research in order to contribute to the knowledge about the research problem. It also comments on both strengths and limitations of the reported studies, the methodologies used to gather information, research findings and recommendations for further research (Johnson & Christensen, 2004).

For the research to make substantial contribution to the topic, it must be based on adequate knowledge of the field or area of enquiry. Walter, Meredith & Joyce (1996:48) outline five important questions that a researcher should ask and answer during literature review in developing a research proposal, thus: "Has the research on this problem been conducted previously? If so, what has been learnt? What more can I contribute to what is already known? Are the methods that I intend to use worse than, as good as, or better

than the methods used by other researchers? Is my research problem significant, or are there more compelling research problems that should be addressed?"

For this particular study it was important to extensively review the literature on the use of teaching for understanding to provide information and insights of what is already known and unknown about the research problem. Perkins (1992) found that there are several studies conducted so far on teaching for understanding particularly in mathematics, science and language education worldwide. These existing literature shows that teaching for understanding is well researched and much is known about its applications in the education arena, in the American context in particular. Discussion about teaching for understanding and its benefits have dominated topics on education websites, i.e., on Google search engine, electronic sources, journals, books, project reports and others. Nevertheless, most literature that was available at the researchers' disposal was about studies done outside Namibia. In the Namibian context, teaching for understanding has not been sufficiently researched, hence this study might contribute to knowledge on teaching for understanding in the Namibian context.

The use of teaching for understanding approaches

Teaching is an essential profession, one that makes all other professions possible. Without well qualified and committed teachers neither improved curriculum nor assessments will ensure that students are prepared for the challenges and opportunities of the 21st century. This can only be achieved when teachers are able to prepare school

activities that require students' application of new knowledge into real life situations (Ball, 2003).

Since 1983, critics of public education in America have argued that many American students do not possess the depth of knowledge or the skills to assure either personal life success or national economic competitiveness (Blythe & Perkins, 1998). Blythe & Perkins further stated that a popular concern in American Education by the critics has been the apparent inability of many students to be involved in complex problem solving activities and to apply school knowledge and skills to real life problems in workplace settings. That students fail to meet such expectations should not be surprising since the traditional measures of school outcomes, standardized achievements tests, have not required the application of knowledge in new settings (Perkins, 2002).

If, as critics (Blythe & Perkins, 1998; Perkins, 2002) suggest, adult success in the 21st century is dependent on the ability to think effectively with clarity, to solve a problem, to collaborate, to communicate clearly, to participate in civic affairs, and is dependent on the possession of an ethical core, then schools must do their work in new ways and the school assessment system should determine whether these goals have been achieved. What teachers and schools face is a fundamental redefinition of what it means to be a student or a teacher and what it means to learn or to teach. Educators must learn to work with students in fundamentally different ways for students to learn meaningfully (Kickbusch, 2000).

According to Coombs (1995), teaching for understanding requires use of multiple approaches. Teaching is a challenge and teachers must seek and strive for ways to make learning more effective. This search for improvements keeps teaching alive. Coombs further explained that no matter how successful a course has been, with happy students and good results, a teacher should be looking ahead and considering possible changes to be made to the next course. An open mind, a willingness to change when the need for change is obvious will keep a teacher updated and in the mainstream of demanding teaching techniques that foster understanding. Coombs further pointed out that since the focus of a constructivist classroom is on cognitive development, the teacher must have extensive knowledge of the subject being taught and of how students learn the subject. More specifically, teaching for understanding requires that the conceptual frames of the student in that subject be known so that strategies which produce change and growth can be developed.

Steinberger (1994), explained the use of teaching for understanding as an application of knowledge in new circumstances; "I consider an individual to have understood when he or she can take knowledge, concepts, skills and facts and apply them in new situations. But, if students simply parrot back what they have been told or what they have read in a textbook, then we do not really know whether they understood" (Steinberger, 1994:26-27). In other words the teacher must be able to create a social environment in the classroom that could be described as a learning community where dialogue can promote understanding. The teacher's role is not just to present information but also to develop strategies which will support and respond to students' learning. The students' role is not

just to absorb or copy but to actively make sense and construct meaning. The social environment including the classroom environment, classroom activities and assessments are discussed in the next section.

How the school environment, classroom activities, and assessments support teaching for understanding

Besides the use of teaching for understanding, Battista (1994) notes that educators understand that changes in students' outcomes must be supported by parallel changes in curriculum and instruction. However, it is apparent that many of today's teachers including Namibians are caught in the midst of a change for which some may not have been professionally prepared. In the Namibian context, many teachers are educated in classrooms where the role of the student is to memorise information, conduct well-regulated experiments, perform mathematical calculations using a specific algorithm, and were then tested on their ability to repeat these tasks or remember specific facts (MBESC, 1996). Battista's (1994) study revealed that all education stakeholders, parents, citizens, employees, students and others face a scale of educational change for which their experiences have not prepared them. Their beliefs about "how schools ought to be" are in tension with the new expectation of "what schools ought to accomplish" (Battista, 1994:463).

According to Perkins (1988), teachers who teach for understanding have many roles to play but largely as facilitators of knowledge construction. They should provide opportunities for students to explore through all appropriate senses and be fully involved

by encouraging cooperative learning that will foster students' attainments. Teachers are expected to interact with students to discover and use ideas formed from exploration to construct concepts and meaning sensible to them. Blythe & Perkins (1998) identified guiding principles that teachers should follow if they are to teach for understanding. According to them, these principles are applicable to any subject or academic setting. The five principles for teachers to teach for understanding include:

1. Make learning a long-term thinking centred process. The teacher must arrange for the students to think with and about the ideas they are learning for an extended period of time, so they learn their way around a topic;

2. Provide for rich ongoing assessment. Students need criteria, feedback, and opportunities for reflection from the beginning of any sequence of any instruction in order to learn for understanding. This means that occasions of assessment should occur throughout the learning process from the beginning to the end, involves feedback from the teacher, from peers, sometimes the teacher may give criteria and sometimes engage students in defining their own criteria;

3. Support learning with powerful representations. How information is represented can influence enormously how well that information supports understanding performance. The teacher needs to add more intuitive, and evocative representations to support students' understanding;

4. Pay heed to developmental factors. The theory devised by the seminal developmental psychologist Jean Piaget revealed that children's understanding was limited by the general schemata they had involved. Teachers do well to bear in mind factors like complexity, but without rigid conceptions of what students can and cannot learn at certain ages;

5. Teach for transfer. Very often students do not carry over facts and principles they acquire in one context into other contexts. They fail to use in science class or at the supermarket the mathematics they learnt in mathematics class. They fail to apply the writing skills that they mastered in English on a history essay. Knowledge tends to get glued to the narrow circumstances of initial acquisition (Blythe & Perkins, 1998:12 – 14).

In other words, if we want to teach for understanding and put to work learning in diverse settings the understanding students acquire, we need to teach explicitly for transfer, helping them to make the connections between lesson and life (Blythe & Perkins, 1998).

In support of Battista (1994), Kickbusch (2000), and Perkins (1996), Coombs (1995) explained that before teaching a class, it is essential to prepare enough and suitable teaching materials that will link up with other subject areas, and/ or show the relevance of the subject being taught to a much wider picture. Students who do not like, or are not particularly good at a subject may respond with more interest and enthusiasm when they can appreciate the relevance of what they are being taught to their lives.

According to Burns (1994), for many teachers, the text book and standardised tests give the real message about what should be taught in the classrooms. Burns explained that judging from the content of textbook lessons and standardised tests, the message is that children must develop proficiency in paper and pencil and arithmetic calculations. Burns further explained that the change from teaching standard algorithms to having children invent their own methods requires a major shift for many teachers. It requires first that teachers value and trust children's inventiveness and ability to make sense of numerical situations, rather than their diligence in following procedures. It also requires teachers to be curious about children's ideas, to take delight in their thinking, and to encourage their creativity (Baron, 1990).

According to Brophy (1992), classroom activities and assessments have significant implications for the way the school should function. He explained that activities should be prepared in recognition that students do not merely passively receive or copy input from teachers, but instead actively try to make sense of the activities and are able to relate them to what they already know or think they know about the topic. Thus students

develop new knowledge through a process of active construction. On the same topic, Baron (1990) argued that in order to get beyond rote memorisation and achieve true understanding, students need to develop and integrate a network of associations linking new input to pre-existing knowledge and beliefs anchored in concrete experience.

Brooks & Brooks (1990) respond to the above arguments that the idea of constructivism, and teaching for understanding in particular, presents a major conceptual challenge, that is, it requires teachers to re-think both about classroom activities as well as what teaching for understanding framework required from them. Writing on the similar theme, Burns (1994) stated that constructivist theory challenges the more traditional beliefs about knowledge and learning. That implies that teachers need to understand the complex nature of knowledge and the importance of influences of students' prior knowledge on subjects in order to face the challenges regarding teaching for understanding. The challenges and problems regarding teaching for understanding are discussed in the next section.

Challenges and problems regarding teaching for understanding

Blythe (1994) supported teaching for understanding as a way to the formation of knowledge and understanding. Blythe revealed that while most teachers agree that the traditional approach to teaching promotes neither the interaction between prior and new knowledge nor the conversations that are necessary for deep understanding, there are also some difficulties about teaching for understanding.

According to Blythe (1994), to help students develop understanding, teachers need to employ a number of strategies, i.e., to strive to explain clearly, seek for opportunities to clarify, and assign open-ended tasks such as planning an experiment or critiquing a book or debating issue-tasks that call for and build understanding. Blythe explained that, helping students acquire understanding is not difficult and it is not an easy job either. Teachers commonly find that their students understand much less than they hoped for. Students get confused by fractions and algebraic formulas, they miss the point of poems, and they have trouble writing essays that show understanding. Moreover, teachers get more frustrated as students usually do not see the connections between what they learn in school and what they do outside of school (Blythe, 1994).

Kettle & Sellars (1996) studied challenges that mathematics teachers meet in teaching student teachers in Finland Colleges of Education. The study analysed teacher educators' reflective writings and interviewed them extensively about their teaching for understanding. The findings revealed that teachers are confused and have difficulties on how to prepare activities and assessments that foster understanding. The findings further showed that teachers usually had unanswered questions such as: why is it so hard to teach

for understanding? Why do students not seem to remember anything from the previous unit once they move on to the next unit? Furthermore, the study revealed that teachers also found it difficult to create experiences for their learners that could connect what they already know with new experiences.

Dilemmas identified by Kettle & Sellars (1996) were (a) teachers find it difficult to prepare students with tests that offer support to the teaching and learning for understanding, and (b) teachers find it difficult to answer the questions of what curricula, activities and assessments best support teaching for understanding. Kettle & Sellars' study revealed that promoting students' understanding must be supported by public policy. In other words, public support must be built not only for instructional strategies which lead to higher levels of student performance but also for assessment strategies which enable students to demonstrate their competence. Support and training regarding teaching for understanding are discussed in the next section.

Support and training needed to ensure effective application of teaching for understanding

Kettle & Sellars' (1996) study mentioned above criticises teacher education institutions, claiming that teacher educators are also in a similar dilemma of finding it difficult to prepare students with activities that offer support to the teaching and learning for understanding. The study poses challenges to all stakeholders in education and Namibian education system in particular. Perhaps the most important challenge in improving the quality of our education system is to ensure that our teachers are prepared for the

responsibility they carry, in order to overcome the challenges posed by overcrowded classrooms, lack of availability of visual aids, and lack of facilities (MEC, 1993). The Ministry of Education and Culture (1993) further explained that, schools need to set up situations in which teaching can be applied successfully and establish classroom norms that support understanding.

Ball (2003) argued that what teachers know and are able to do is of crucial importance to the nation, as is the task of preparing and supporting the career development of teachers' knowledge and skills. Ball further explained that new teachers are expected to become effective teachers within a few weeks of in-class training, while society does not expect our doctors to perform surgery after just a few weeks of clinical experience. That implies that comprehensive induction programs should provide new teachers with the necessary models and tools for beginning their teaching careers, as well as the mentors and support groups to guide them through curriculum planning.

According to Kickbusch (2000), if professional development is to be consistent with constructivist theory, beliefs about teaching and learning for understanding can not be left to the vagaries of traditional in-service activities. Kickbusch further supported teachers' professional development saying that a consistent professional development strategy would accept teacher learning as a process of construction, the existence of prior professional knowledge, and the existence of diverse knowledge structures.

Evidence from the reviewed literature indicates that teaching for understanding is a meaningful way of helping learners to grasp the significance of what they are to learn. However, a number of challenges were identified from the literature reviewed that hinder effective teaching of mathematics for understanding. Teacher training, availability of teaching resources, and classroom environment were highlighted in this chapter as some of the factors hindering teaching of mathematics for understanding.

In the next chapter the methodology used in collecting, analysing, and presenting the data is described.

CHAPTER 3

RESEARCH METHODOLOGY

Research design

The study was descriptive in nature. A descriptive study according to Borg, Gall and Gall (1996) is a description of natural and man-made phenomena and is mainly based on individual opinion. Data were collected and described in a holistic manner pertaining to the teaching of mathematics for understanding by mathematics teachers in their classrooms. In order to answer all the research questions of the study, a combination of both quantitative and qualitative modes of enquiry were employed. Observations and interviews were conducted among mathematics teachers in eight selected secondary schools in the Omusati Education Region.

Population

According to Best & Kahn (1998) a population is any group of individuals that have one or more characteristics in common that are of interest to the researcher. In this study, all senior secondary school mathematics teachers in the Omusati Education Region constituted the population. There are 12 senior secondary schools and 32 teachers teaching mathematics at senior secondary school level (grade 11 – 12) in the Omusati Education Region. These senior secondary schools are divided into seven circuits, each circuit with one to two senior secondary schools.

Sample and sampling procedures

In this study, 20 mathematics teachers were selected from 12 secondary schools in the Omusati Education Region to participate in the study. Two types of sampling were employed to select the sample, namely: the cluster sampling technique and the maximum variation sampling technique, in order to obtain a good representation of mathematics

teachers in the Omusati Region. According to McMillan and Schumacher (2001) maximum variation sampling technique is an approach to sampling used by qualitative researchers that involves the purposeful selection of study participants with a wide rage of variation, i.e., teachers' number of years of teaching experience. In this study, maximum variation sampling technique was used to select all the clusters centres from seven school circuits in the region to participate in the study.

Cluster sampling technique, according to McMillan and Schumacher (2001), is a sampling technique used when the entire population is divided into groups, or clusters, and random samples of these clusters are selected. In this study, cluster sampling technique was used to get a list of all senior secondary schools in the region that were cluster centres.

The following procedures were used to select the sample from the total population. First, the existing school circuits developed by the Ministry of Basic Education Sport and Culture were used to classify the participating schools into seven circuits. Second, the schools to participate in the research study were selected from the circuits using maximum variation and random sampling techniques. Senior secondary schools that are cluster centres were automatically selected because they were believed to provide necessary information since one of the criteria used to select cluster centres was that they had enough facilities. Third, one school was randomly selected from three circuits that had two senior secondary schools each. At present each circuit is made up of 1 to 2 senior

secondary schools making a sample size of 20 (62.5%) of the total population of 32 senior secondary school mathematics teachers in the region.

Fourth, the number of years of teaching experience was used to select participants in the study using maximum variation sampling technique at each of the sample schools. For example a teacher with one year teaching experience and one with more than five years' teaching experience were selected from each sample school. This was done to eliminate the feeling among teachers that experience was sufficient to improve their teaching of mathematics for understanding. The two sexes were equally presented in the study using stratified sampling. This was done in order to obtain a sample representative of the whole population in terms of sex.

Research instruments

Structured interviews, informal interviews and direct observations were used to collect data from the sample. These methods were chosen in order to understand mathematics teachers' views and practices about the teaching for understanding framework. An interview protocol and self-designed observation schedule were used to collect data from the 20 mathematics teachers on how they taught mathematics for understanding in their classrooms. Both instruments were used to collect data from the mathematics teachers on the constraints they encountered as well as the training and support that they needed to improve their instruction. The data were recorded on the spaces provided in the interview protocol. Likewise, the behaviour and the interactions between the teacher and the

students during classroom instructions that were observed were recorded on the observation checklists.

Observations

Continuous observation of the whole period was undertaken in order to get clear evidence on teachers' teaching for understanding. The data were recorded on the observation schedules. The observation schedules were designed to collect information regarding whether the mathematics teachers taught for understanding in their classroom and whether their lesson objectives as well as activities and assessments used to prepare their students were in accordance with the teaching for understanding framework. The observation schedules were designed to evaluate whether mathematics teachers applied teaching for understanding approaches and the extent to which they practiced them in their teaching. According to Blythe (1998), in teaching for understanding, teachers should employ verbs such as: deduce, explain, compare, interpret, predict, find evidence, derive formulas, generalize, apply, and represent the new topic in new ways, in their lessons.

Interviews

Interviews with the 20 selected teachers were conducted to determine whether the respondents applied mathematics instruction for understanding approaches. The interviews also helped to determine how school environments, assessments and classroom activities that teachers used to prepare their students could best support teaching mathematics for understanding. The interview questions were also focused on the problems encountered by the mathematics teachers when teaching for understanding,

the initiatives they took to improve their instruction as well as the support they needed to improve their teaching for understanding. Further more, the interviews helped to verify and supplement information obtained from the observations as well as the information that were impossible to get from the observations such as teachers' understanding of the teaching for understanding framework. The responses were recorded in the interview protocol.

Data collection procedures

The following steps were taken into consideration in collecting data. First, a letter of authorization and introduction of the researcher was obtained from the University of Namibia. Second, the researcher wrote a letter to the Director of the Omusati Education Region to seek permission to carry out a study in the region. Third, after permission was granted at the regional level, the researcher wrote another letter to the selected school principals to ask permission to carry out the study at their schools. Fourth, the researcher visited regional offices, sample schools, met school principals and made appointments with the informants to inform them about the study as well as to establish good rapport between the researcher and the informants. Fifth, the researcher piloted the instruments with mathematics teachers at one secondary school in the Khomas Education Region. The final instruments were adjusted and checked by the two supervisors before the actual data collection. The adjustments were necessary to enhance both the construct and content validity of the research instruments. Participants were given the researcher's information letter to ascertain informed consent and confidentiality. The selected teachers

were then approached for personal interviews, which were followed by classroom observations.

Data analysis

The analysis of data was done using descriptive statistics, frequencies and percentages. According to Walter, Meredith & Joyce (1996), descriptive statistics involves assessing attitudes, behaviours and / or opinions towards individuals, organisations, policies and procedures in order to answer questions concerning the current status of the subject of the study. In this study, information obtained from the interviews and the observations were quantified and interpreted, using number scores that were converted to the percentage of the occurrence of teaching for understanding that were observed and the respondents' responses. Presentation of data was organized and presented through descriptions, tables, bar graphs, pie charts and discussion of research results was interpreted in a narrative form.

CHAPTER 4

PRESENTATION OF FINDINGS

Introduction

The data that were obtained through the use of the two research instruments: interview questions and lesson observations are presented under six subheadings. The results are presented, analysed and were interpreted according to the objectives of the study outlined in Chapter 1. The subheadings of this chapter include:

1. Biographical information of the participants.
2. Teaching for understanding approaches used by mathematics teachers.
3. The extent to which the mathematics teachers practice the teaching for understanding approaches in their teaching.
4. The school environment, classroom activities, and assessment that support teaching for understanding.
5. Challenges and problems faced in teaching for understanding.
6. Support needed to ensure effective application of teaching mathematics for understanding.

BIOGRAPHICAL INFORMATION OF THE PARTICIPANTS

Biographical information such as sex, ages, subject taught by participants, teaching experience and teaching qualifications of the participants were included in the study.

Sex of the respondents

A total of 20 mathematics teachers from 12 Senior Secondary Schools in the Omusati Education Region participated in the study. Of the 20 participants 10 (50%) were males and 10 (50%) were females. Stratified sampling was used to obtain a sample representative of the whole population in terms of sex. This was done to eliminate the

feeling among the teachers that male teachers could teach better mathematics for understanding than female counterparts and vise verse.

Ages of the respondents

The participants were also asked to indicate their ages. The results are given in figure 1.

F**igure 1: The ages of the participants (N=20)**

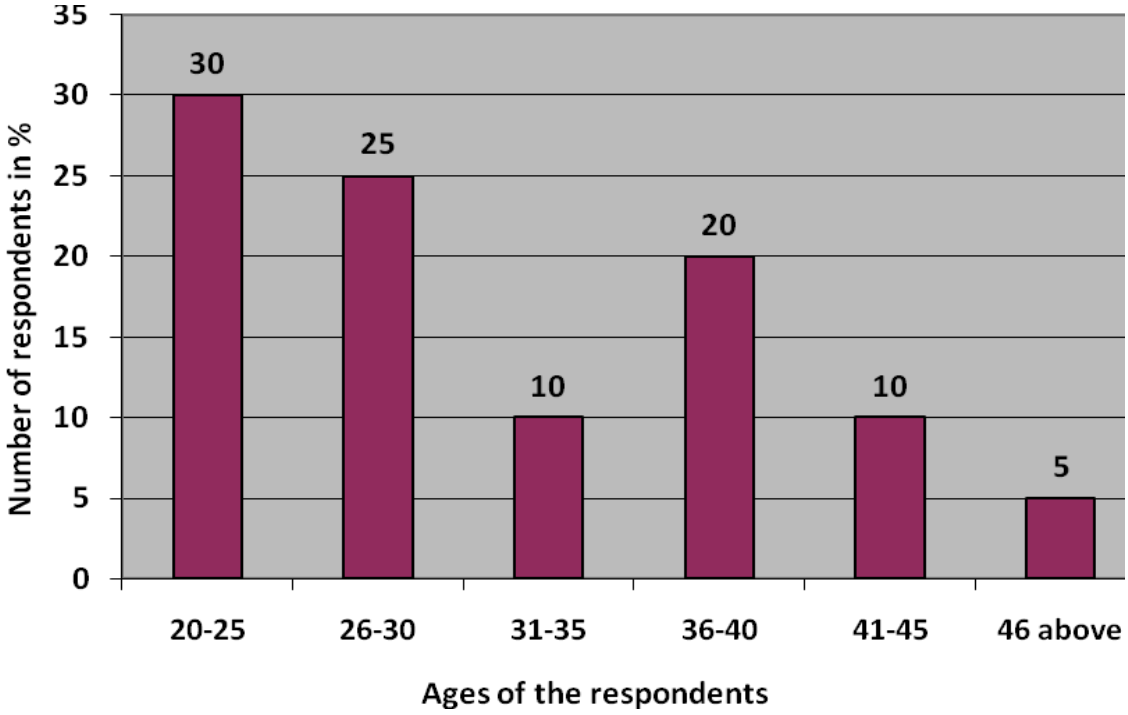


Figure 1 shows that six (30%) of the teachers were aged between 20-25 years, five (25%) of the teachers were between the ages of 26-30 years, two (10%) were between the ages of 31-35 years, four (20%) were between the ages of 36-40 years; two (10%) were between the ages of 41-45; and one (5%) of the participants was at the age level of 46 years and above.

Subjects taught by the participants

The participants were senior secondary school mathematics teachers; but a number of them taught mathematics and other subjects in school as shown in figure 2.

Figure 2: Subject(s) taught by respondents in percentages (N=20)

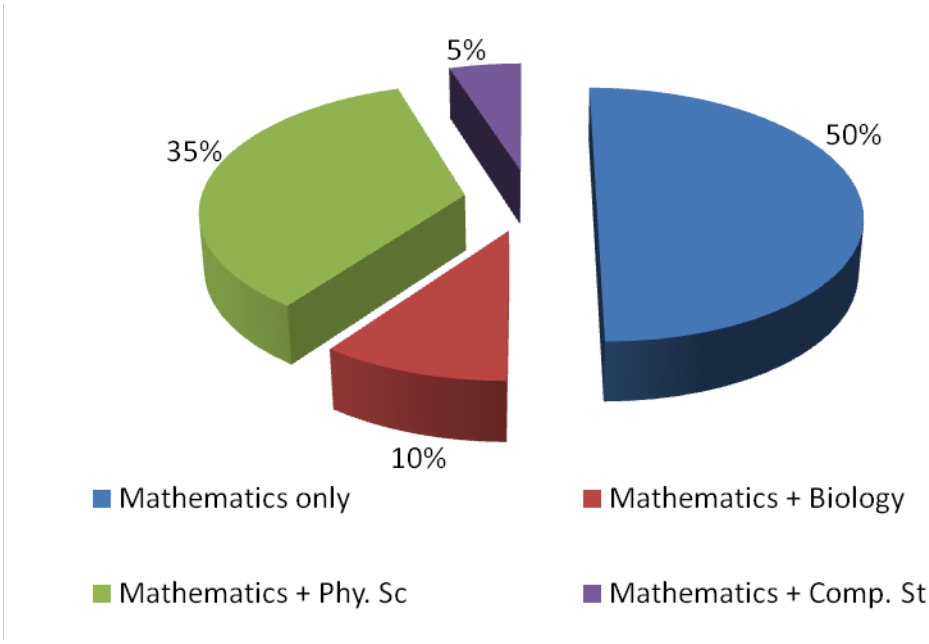
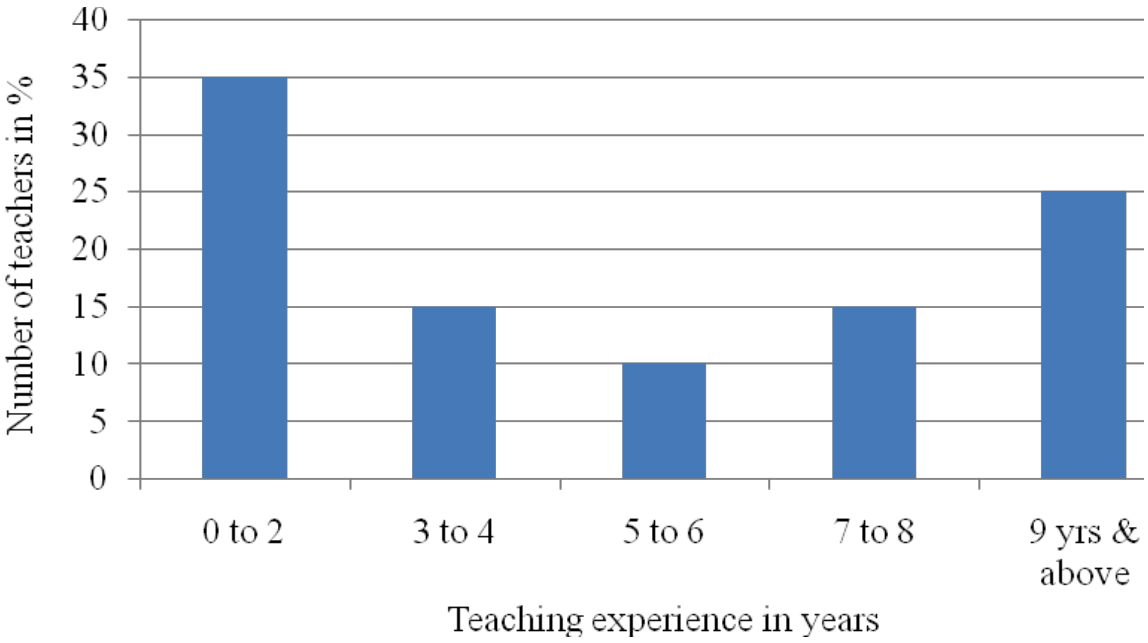


Figure 2 shows that 10 (50%) of the participants taught Mathematics only, seven (35%) taught Mathematics and Physical Science, two (10%) of the participants taught Mathematics and Biology and one (5%) of the participants taught Mathematics and Computer Studies.

Teaching experience of the participants

Participants were asked to indicate their teaching experience in years. It was assumed that teachers might feel that experience was sufficient to improve their ability to teach mathematics for understanding. The results are given in figure 3.

Figure 3: Participants' years of teaching experience (N=20)

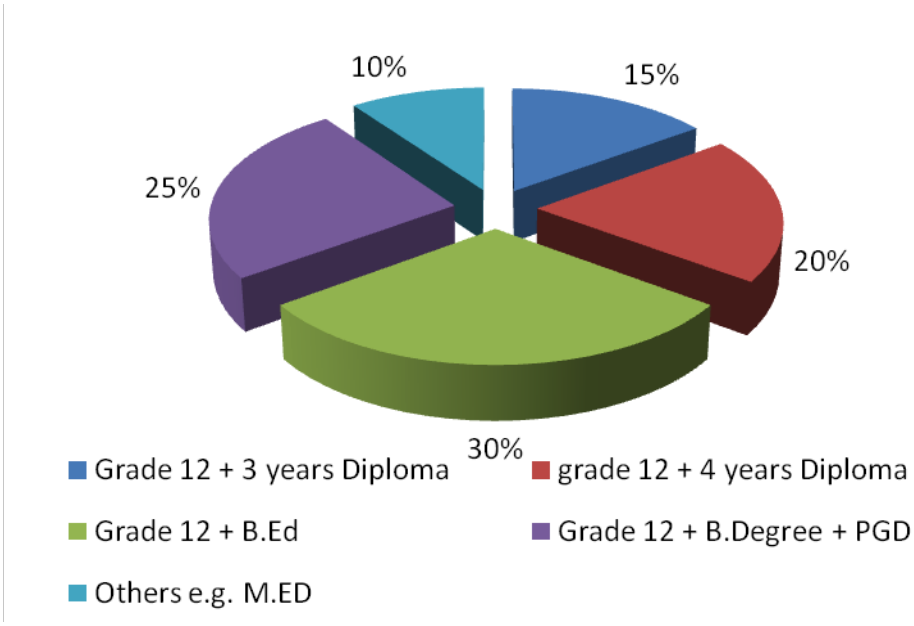


The findings illustrated in figure 3 show that seven (35%) of the participants had teaching experiences ranging from 0 to 2 years, three (15%) of the participants had 3 to 4 years of teaching experience. Two (10%) of the participants had teaching experience of 5 to 6 years, three (15%) of the participants had 7 to 8 years of teaching experience and five (25%) had teaching experience of 9 years and above.

Teaching qualifications of the participants

Participants were also asked to indicate their highest teaching qualifications. The responses given by the participants are given in figure 4.

Figure 4: The participants' teaching qualifications (N=20)



The findings illustrated in figure 4 show that, three (15%) of the respondents had a three year teaching diploma, four (20%) had a four year teaching diploma, six (30%) had a Bachelors degree in Education, five (25%) had a Bachelors Degree plus a postgraduate diploma in Education and two (10%) had other teaching qualifications.

TEACHING FOR UNDERSTANDING APPROACHES USED BY MATHEMATICS TEACHERS

According to Berger & Luckmann (1966), teaching for understanding requires teachers to educate students to exhibit what they know and what they can do with what they know in a real time dimension. The teacher is expected to use verbs like explain, find evidence, derive formulas, generalize, present the topic in new ways, suggest, etc, in the lesson objectives for students to learn meaningfully.

Teaching for understanding approaches used by the participants

In order to determine the use of teaching for understanding approaches used by the mathematics teachers, the participants were asked to give approaches that they often used

in teaching their lessons. The idea was to identify teaching for understanding approaches that were known to the participants and how they applied them in their classroom instruction. The participants' responses are presented in Table 1.

Table 1: Teaching methods often used by participants during classroom instructions (N=20).

Teaching approaches often used by mathematics teachers	Frequency (%)
Demonstration method	5 (8.8)
Discussion method	4 (7.0)
Discovery method	5 (8.8)
Exploration & Investigation	5 (8.8)
Lecture Method	4 (7.0)
Chalk and Talk	5 (8.8)
Observation	6 (10.5)
Projects	3 (5.3)
Peer Teaching	4 (7.0)
Question & Answer	5 (8.8)
Problem Solving	11(19.3)
Total	**57(100)**

- ❖ Teachers indicated more than one method.

It was interesting to find that teachers used a variety of teaching approaches in teaching mathematics as shown in Table 1. These teaching methods in order of use were: 11 (19.3%) of the participants used problem solving method, 6 (10.5%) used observation, 5 (8.8%) used demonstration, discovery method, question and answer method, learning through investigation and exploration and chalk and talk method respectively. Four (7.0%) of the participants used discussion, lecture method, and peer teaching respectively, while, three (5.3%) used projects as an instructional approach.

All (100%) of the participants indicated that they used two or more of the learner centred related approaches that supported teaching for understanding such as learning by doing, discovery method, problem solving, demonstration, exploration, investigation, discussion and projects. However it was observed that only five (8.8%) of the participants encouraged students to learn by doing through enquiry, discovery, investigation and demonstration methods during their instructional process. It was also interesting to note that the lecture and the chalk and talk methods were used by four (7.0%) and five (8.8%) respectively of the participants (See Table1).

Participants' knowledge of the use of teaching mathematics for understanding

Table 2 illustrates the participants' knowledge of the use of teaching mathematics for understanding. The participants were asked to rate their views using a 5 point scale on the statement that *understanding in mathematics teaching is very much important*. The five point scale was: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree.

Table 2: Teachers rating of the statement: "*understanding in mathematics teaching is very much important" (*N=20)

Teachers' rating	**Frequency (%)**
Strongly agree	18(90)
Agree	1(5)
Neither agree nor disagree	1(5)
Disagree	0(0)
Strongly disagree	0(0)
Total	**20(100)**

Table 2, shows that one participant neither agreed nor disagreed that teaching for understanding was very much important in mathematics teaching. The participant explained that in the Namibian context, the syllabus was too long and periods were too short to teach for understanding. "What is the use of teaching for understanding if you know you will not finish the syllabus?" the participant asked.

However, from Table 2 it is obvious that mathematics teachers agreed that understanding in mathematics teaching was very much important. Eighteen (90%) of the participants strongly agreed with the statement. On the other hand, to the question, "what does teaching for understanding mean to you?" it was found that only four (20%) of the participants knew and understood the teaching for understanding framework (see Table 3).

Table 3: Teachers' understanding of the teaching for understanding framework (N=20)

Knowledge of teaching for understanding framework	**Frequency (%)**
Know and understand teaching for understanding Framework	4 (20)
Able to link teaching for understanding to Constructivism Theory	10 (50)
View teaching for understanding as a completely new concept	6 (30)
Total	**20 (100)**

The interview results in table 3 revealed that 50% of the participants were able to link the teaching for understanding to the constructivism theory, while 30% of the participants viewed teaching for understanding as a completely new concept to them.

Participants were also asked to explain why teachers needed to teach mathematics for understanding. The responses are presented in Table 4.

Table 4: Reasons, why teachers needed to teach mathematics for understanding (N=20)

The importance of teaching mathematics for understanding	Frequency (%)
For students to apply learnt maths content in different contexts	2(10)
Students will be able to master the content they have learnt	2(10)
Students will be able to apply mathematics outside of the classroom	1(5)
Students will be able to pass their exams at the end of the course	15(75)
Total	**20(100)**

From Table 4, the participants gave the following reasons for teaching mathematics for understanding: two (10%) indicated that students would be able to apply the mathematics knowledge they learnt in different contexts. Another two (10%) of the participants indicated that students would be able to master the content learnt, and one (5%) indicated that students would be able to apply mathematics skills outside the classroom. The majority (75%) of the participants indicated that teaching for understanding was essential for students to be able to pass their examinations at the end of the course.

Participants were also asked to indicate how one could tell that a student had learnt with understanding a mathematics topic. Their responses are given in Table 5.

Table 5: Participants' ability to explain when a student had learnt mathematics for understanding (N=20)

Participants' explanations of when a student had learnt mathematics for understanding	Frequency (%)
Able to explain when a student has learnt for understanding ✓ the student will be able to demonstrate the learnt skill ✓ the student will be able to find examples of the lesson at home ✓ the student will be able to explain the content in new ways ✓ the student will be able to solve thought provoking tasks ✓ the student will be able to help other peers to understand the learnt activities	5 (25)
Not able to explain when a student has learnt for understanding ✓ the student will be able to complete his / her homework ✓ the student will be able to pass the exams at the end of the course	15(75)
Total	**20(100)**

Table 5 shows that five (25%) of the participants were able to explain when a student had learnt mathematics for understanding. Explanations such as the student would be able to demonstrate the learnt skill, able to find examples of the lesson at home in everyday experiences, able to explain the content in new ways and able to solve thought provoking tasks were given. On the other hand, 15 (75%) of the participants gave explanations such as students would be able to complete their homework and pass examinations at the end of the course (see Table 5).

Participants were asked further to explain how to teach mathematics for understanding. Their responses are presented in Table 6.

Table 6: Explanations of how to teach mathematics for understanding (N=20)

How to teach for understanding	Frequency (%)
Supporting teaching for understanding ✓ By indicating goals that describe what a teacher wanted students to get out of the activities in a particular topic; ✓ provide students with clear explanations and feedback; ✓ plan activities driven from real life situations; and ✓ Guide them to derive mathematics formulas.	11 (55)
Not supporting teaching for understanding ✓ Using old question papers; ✓ give students homework everyday; ✓ give students a quiz after every lesson; and ✓ Provide them with handouts and summaries.	9 (45)
Total	**20(100)**

Table 6, shows that 11(55%) of the participants indicated the relevant strategies on how to teach for understanding. The participants indicated that teachers should indicate goals that described what they wanted students to get out of activities within a particular topic, provide students with clear explanations and feedback to their learning performance, plan activities that derived from real life situations and guide them to derive mathematical formulas. The other nine (45%) of the participants indicated that they used previous question papers, they gave students homework everyday, they gave students a quiz after every lesson and provided them with handouts and summaries.

On the question of whether the instructional approaches the participants had indicated in Table 1 served the purpose of teaching mathematics for understanding, ten (50%) indicated that not all instructional approaches used served the intended purpose. They explained that chalk and talk methods were used due to insufficient teaching facilities / resources such as text books and classrooms with broken windows and doors that prevented teachers from displaying teaching materials on the walls. The remaining 10 (50%) of the participants said "yes." The participants used learner-centred related

approaches such as problem solving, discovery, learning by doing, exploration and investigation, observation and demonstration during their classroom instructions in order to teach mathematics for understanding.

THE EXTENT TO WHICH THE MATHEMATICS TEACHERS USED AND PRACTICED TEACHING FOR UNDERSTANDING APPROACHES IN THEIR TEACHING

After the interviews, participants were observed during teaching mathematics lessons to ascertain the extent to which they used and practiced teaching for understanding approaches in their teaching. The behaviour(s), skills and / or approaches observed are presented in Table 7. The responses "yes" or "no" were used to indicate the prevalence of the behaviours, skills and / or approaches that were observed.

Table 7: A summary for behaviours, skills and approaches exhibited by the participants during lesson observations (N=20)

Behaviour(s) / skills / approaches observed	Frequency (%)		Total
	Yes	No	
The teacher uses activities that make understanding a more central and reachable objective(s) in his / her class	8(40)	12(60)	**20(100)**
The teacher uses teaching activities that draw on the teaching for understanding framework	6(30)	14(70)	**20(100)**
The teacher uses verbs such as: explain, find evidence, derive formulas, generalize, represent the topic in new ways, deduce, create, suggest, etc , in the lesson objectives	10(50)	10(50)	**20(100)**
The teacher allows students to interact constructively with one another in building and integrating new knowledge from experiences	7(35)	13(65)	**20(100)**
The teacher teaches explicitly and allows students to make connections to meaningful contexts outside the classroom	4(20)	16(80)	**20(100)**
The teacher encourages all students to actively participate in their own learning process	9(45)	11(55)	**20(100)**
The teacher provides students with rich ongoing	3(15)	17(85)	**20(100)**

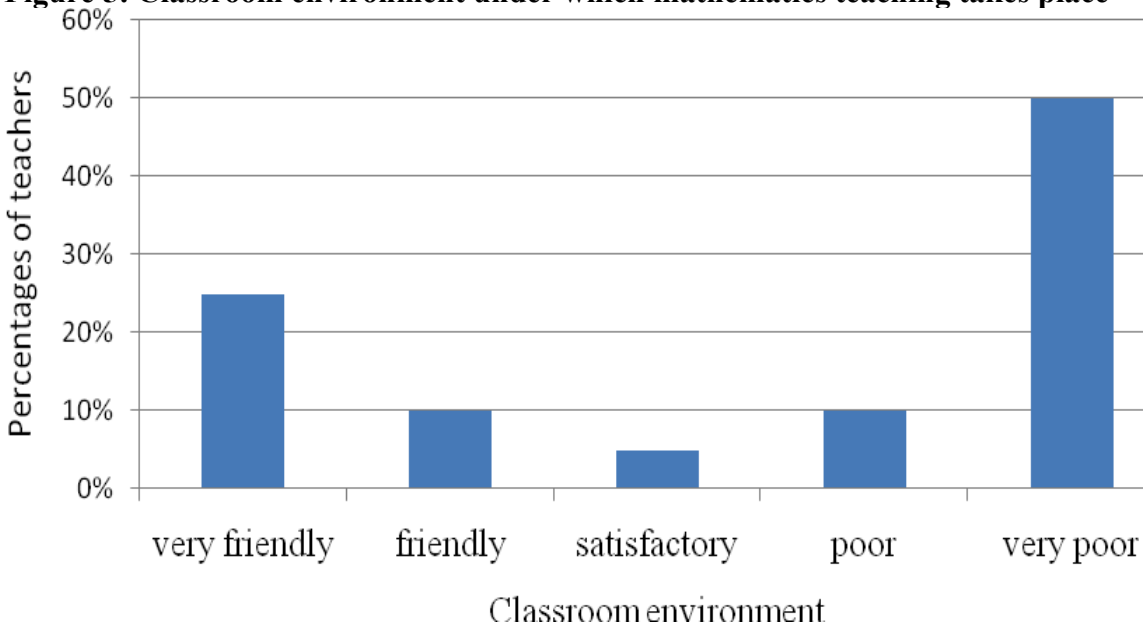
assessments and feedback that foster understanding of mathematics			
Encourages students to think beyond what they already know	8(40)	12(60)	**20(100)**
The teacher puts the students' needs into consideration	9(45)	11(55)	**20(100)**
The teacher allows the students to evaluate each others' work	5(25)	15(75)	**20(100)**
The teacher encourages students to learn by doing through problem solving, discovery, observation and demonstration	11(55)	9(45)	**20(100)**
Instructs students to engage in thought provoking activities	8(40)	12(60)	**20(100)**
The teacher asks questions that they (teachers) answer themselves	12(60)	8(40)	**20(100)**
The teacher seeks elaboration of learners' initial responses	8(40)	12(60)	**20(100)**

Table 7 shows that 12 (60%) of the participants (teachers) asked questions that they answered themselves, meaning that participants gave explanations that showed that they had prepared the answers beforehand. Eleven (55%) of the participants encouraged students to learn by doing, ten (50%) of the participants used verbs such as explain, demonstrate, derive, suggest, create and convert in their lesson objectives while another 50% of the participants were observed using words like understand, know, mention and write in their lesson objectives. Nine (45%) of the participants considered students' needs during their teaching, eight (40%) of the participants used observable objectives, thought provoking activities and elaborated students' initial responses. The same number (40%) of the participants observed encouraged students to think beyond what they already knew and allowed students to interact with others during the lessons.

THE SCHOOL ENVIRONMENT, CLASSROOM ACTIVITIES, AND ASSESSMENT THAT SUPPORTED TEACHING FOR UNDERSTANDING

The participants were asked to indicate how the school environment such as seating arrangements, physical conditions, availability of visual aids, etc., supported teaching /learning for understanding. The teachers' responses are presented on figure 5.

Figure 5: Classroom environment under which mathematics teaching takes place



The findings illustrated in figure 5, shows that 10 (50%) of the participants teaching took place under very poor classroom environments. The teaching of five (25%) of the participants took place in very friendly classroom environments that were conducive to teaching and learning for understanding. Classrooms had intact windows, sufficient chairs and desks, sufficient textbooks and other teaching and learning materials.

The participants were also asked to explain how they ensured that their classroom activities, tests and exams, helped their students to develop understanding in mathematics. Their responses are presented in Table 8.

Table 8: Measures taken by the participants to ensure classroom activities that supported students' understanding (N=36)

Measures taken by mathematics teachers	Frequency (%)
Drawn from the teaching for understanding framework	
✓ Encourage students to derive mathematics formulas	5(13.9)
✓ Encourage students to solve problems deductively	1(2.8)
✓ Encourage students to present the content in new ways	2(5.6)
✓ Encourage students to explain their answers	7(19.4)
✓ Encourage students to draw conclusions from each activity	3(8.3)
Not drawn from the teaching for understanding framework	
✓ Require students to show all the steps leading to the answer	8(22.2)
✓ Ask students to write formulae first before engaging in any calculation	5(13.9)
✓ Use old question papers as classroom activities in order to cover a whole range of topics in a short period of time.	5(13.9)
Total.	**36(100)**

❖ Teachers indicated more than one measure.

Table 8, shows that 18 (50%) of the responses from the participants indicated relevant strategies that were derived from the teaching for understanding framework. They indicated that they would set up tests, activities and exams where students would be able to derive formulas, solve problems deductively, present the content in new contexts, explain their answers, and engage students in activities that would allow them to draw

conclusions. The other 18 (50%) of the responses indicated strategies that were not drawn from the teaching for understanding framework. They indicated strategies such as asking students to show all the steps that led to the answer(s), writing the formula used before engaging in any calculation and used old question papers to teach.

CHALLENGES AND PROBLEMS REGARDING TEACHING FOR UNDERSTANDING

The participants were asked to indicate by either "yes" or "no" whether they encountered difficulties and challenges when applying the teaching for understanding framework. Twenty (100%) of the participants indicated that it was not easy to teach mathematics for understanding using the approaches they often used in their mathematics teaching due to various factors like overcrowded classrooms, and lack of teaching / learning materials. The participants were also asked to indicate the challenges and / or factors that they thought made it difficult or easy for them to apply teaching approaches that supported the teaching for understanding framework. Their responses are presented in Table 9.

Table 9: Challenges faced in teaching for understanding (N=55)

Challenges encountered by mathematics teachers	Frequency (%)
Poor classroom conditions (broken windows and doors)	5(9.1)
Lack of teaching and learning materials	5(9.1)
Overcrowded classrooms (40-50 students in one classroom)	11(20.0)
Too long syllabus	4(7.3)
Shortage of chairs and desks	3(5.5)
Automatic promotion from grade 11	4(7.3)
Poor involvement of parents	1(1.8)
Short teaching period (40 minutes)	2(3.6)
Insufficient textbooks	8(14.5)
Lack of professional and advisory support services	5(9.1)
Lack of teaching facilities	6(10.9)

Negative attitudes toward mathematics	1(1.8)
Total	**55(100)**

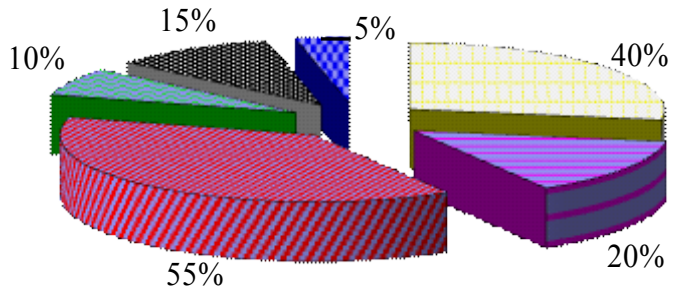
- Teachers indicated more than one challenge encountered during their teaching

From Table 9, it is clear that the participants encountered several challenges in applying the teaching for understanding framework. Eleven (20.0%) of the participants experienced the problem of overcrowded classrooms with 40-50 students in one classroom. One participant responded that, "I can not reach every student in a class of 47 students, and in most cases slow learners are left behind." Eight (14.5%) of the participants had insufficient numbers of prescribed textbooks, and six (10.9%) of the participants experienced the lack of teaching and learning facilities. Five (9.1%) of the participants experienced difficulties of poor classroom conditions such as broken windows and doors, lack of teaching and learning materials including teaching aids, and lack of professional advisory support services from the principals, subject heads and advisory teachers.

It was further noted that 4 (7.3%) of the participants indicated that they experienced difficulties due to automatic promotion from grade 11 and the same number of participants found the syllabus for grade 11 and 12 too long to finish within two years. Two (3.6%) of the participants indicated that the teaching period (40 minutes) was too short to teach for understanding, and only one (1.8%) participant indicated poor involvement of parents in their children's education.

The participants were also asked to indicate how they dealt with the mentioned challenges in Table 9 during their teaching. Their responses are presented in figure 6.

Figure 6: How the participants dealt with identified challenges in their mathematics classrooms (N=20)

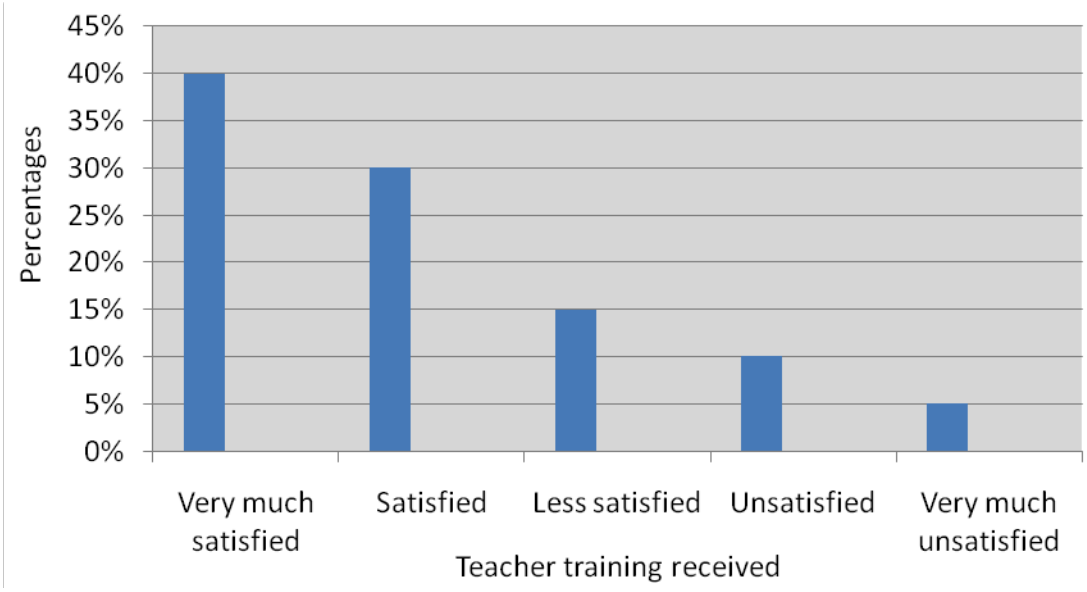


The strategies that were used by mathematics teachers to deal with challenges that hindered the effective use of teaching approaches included: giving extra classes indicated by 11 (55%) of the participants, trying out alternative methods given by eight (40%) of the participants, use local materials as teaching and learning aids, given by four (20%) of the participants. Approach other mathematics teachers for help were given by three (15%) participants, and forwarding their complaint to the management were given by two (10%) participants.

SUPPORT TO ENSURE EFFECTIVE APPLICATION OF TEACHING MATHEMATICS FOR UNDERSTANDING

To establish necessary support and / or training required by teachers regarding teaching mathematics for understanding, the participants were asked to indicate how the teacher training institutions had helped them to teach mathematics for understanding. The responses ranged from very much satisfied, satisfied, less satisfied, unsatisfied, and very much unsatisfied. The responses are presented in figure 7.

Figure 7: Training received from teacher training institution(s) regarding the teaching for understanding (N=20)



It can be noticed from Figure 7 that the majority of the participants eight (40%) and six (30%) respectively were satisfied with the training received from the teacher training institutions in support of teaching for understanding framework. Three (15%) of the participants were less satisfied, two (10%) were not satisfied and one (5%) was very much unsatisfied with the training received from the teacher training institutions. "My training was more content based and less methodology" one participant responded.

To establish necessary support and training required for teachers regarding teaching mathematics for understanding, the participants were further asked to indicate the support and /or training that they needed to apply teaching mathematics for understanding. Their responses are presented in table 10.

Table 10: Support and /or training required by teachers to enable them teach mathematics for understanding (N=20)

Type of support and / or training needed	Frequency (%)
Annual regional mathematics training workshops	4(8.5)
In-service training	5(10.6)
Induction of new mathematics teachers	9(19.1)
Mathematics scholarships / Staff Development	7(14.9)
Regional mathematics teachers' conference	2(4.3)
Advisory teachers' support	4(8.5)
Support from parents and communities	3(6.4)
Learning /teaching materials	2(4.3)
Establish mathematics teachers' associations	6(12.8)
Improving teacher accountability	1(2.1)
Improving professional development practises	4(8.5)
Total	**47(100)**

- Teachers indicated more than one type of support and / or training needed.

Table 10 shows that nine (19.1%) of the participants needed induction courses for new teachers. Participants indicated that new teachers needed to be given induction training opportunities in order to teach effectively. Six (12.8%) needed mathematics teachers association platform to be well established, five (10.6%) needed the in-service training opportunities and four (8.5%) needed advisory teachers' support in some specific mathematics topics and professional development programmes.

This chapter presented the results of the data analysis. In Chapter 5, discussion of the results is presented.

CHAPTER 5

DISCUSSION OF THE FINDINGS

Introduction

The findings are discussed by addressing the research questions. The discussion of the findings is presented under five sub-headings namely:

1. Teaching for understanding approaches used by mathematics teachers.

2. The extent to which the mathematics teachers practice the teaching for understanding approaches in their teaching.
3. The school environment, classroom activities and assessment that support teaching for understanding.
4. Challenges and problems faced in the teaching for understanding.
5. Support needed to ensure effective application of teaching mathematics for understanding.

TEACHING FOR UNDERSTANDING APPROACHES USED BY MATHEMATICS TEACHERS

In order to determine the use of teaching for understanding approaches, the participants were asked to indicate approaches they often used, in teaching their lessons. The idea was to identify teaching for understanding approaches that were known to the participants and how they applied them in their classroom instructions.

Teaching for understanding approaches used by participants

From the information collected from the participants during the interviews and observations it became clear that teachers in the sample used a variety of teaching approaches in the teaching of mathematics. These teaching methods in order of frequency of use were: problem solving, observation, demonstration, discovery method, learning by doing, chalk and talk, question and answer method, discussion, lecture method, peer teaching, exploration and investigation, deduction and projects (see Table 1). The results

appear to suggest that teachers were reluctant to let go of traditional teaching approaches as they complained about the length of the syllabus and the short teaching periods (40 minutes) that prevented them from teaching for understanding (see teachers' views towards the use of teaching mathematics for understanding, p. 44). It also emerged from the data that 25% and 20% of the participants used chalk and talk and lecture methods respectively during their instructional approaches in order to finish the syllabus (see Table 1).

The second assumption that some teachers might not know and understand how the teaching for understanding works was confirmed by classroom observations. Table 7 revealed the participants' use of teaching for understanding approaches. Only 20% of the participants observed allowed students to make connections to meaningful contexts outside the classroom. It is therefore important that teachers' instructions should allow students to make connections to meaningful contexts outside the classroom.

Table 1, 6, and 7 also showed the participants' use of teaching for understanding approaches. The participants indicated various instructional approaches such as learning by doing, learning through enquiry, discovery, observation and demonstration which are based on teaching for understanding framework. However, the use of traditional teaching approaches such as chalk and talk, and lecture methods were also observed among the participants during their teaching.

The sixth assumption that teachers might be influenced by the traditional teaching method that could make some teachers feel uncomfortable with the more demanding reflective and challenging teaching for understanding approaches was only observed in a few (20%) participants' classrooms (see Table 1). It is therefore important that teachers refrain from playing a role of being transmitters of knowledge to passive learners and play the role of facilitators, and engage students in thought provoking activities that would help them to learn for understanding.

THE EXTENT TO WHICH THE MATHEMATICS TEACHERS PRACTICED THE TEACHING FOR UNDERSTANDING APPROACHES

The literature on teaching for understanding framework (Blythe, 1994) suggest that teaching for understanding instructional approaches should encourage students' active participation, learning by doing, making connections between lessons and real life situations, learning through enquiry, finding evidence, and representing the topic in new ways.

Interactions between the teacher and students during classroom instructions

Table 7 revealed how the participants applied teaching for understanding approaches and the extent to which they practiced them during their classroom instructions. Activities that made understanding a more central and measurable objective in the teachers' classes were observed during the participants' teaching. However, only eight (40 %) of the participants used activities that made understanding a more central and measurable

objective in their teaching. Twelve (60%) of the participants were found to have prepared mathematics content and activities that could not create opportunities for students to make sense of what they were doing. The assumption that teaching and learning activities, for which the teachers prepared their students, might not offer necessary support for teaching for understanding was confirmed.

It is therefore important that teachers who teach for understanding should involve students in activities that provide them with opportunities to explore through all the appropriate senses that would foster students' attainments.

It also emerged from Table 7 that many (14 out of 20) participants did not prepare activities that were based on teaching for understanding framework. The participants indicated various activities that could not help students to learn for understanding. They complained that they found it difficult to cope with the type of students that they had. It is important to note that if teachers wanted to teach for understanding, they should avoid the use of secondary materials such as textbooks and start using raw data and primary sources as alternative resources in instruction and learning.

The findings from the lesson observations revealed that half (50%) of the participants' lesson plans analysed seemed to do far better in support of teaching for understanding approaches when writing their lesson objectives. Participants were observed using words such as explain, demonstrate, derive, suggest, create and convert (see results p.50). It was also observed that all participants that wrote their lesson objectives clearly were able to spell them out to their students. The above findings are supportive of those by Blythe

(1994) that mathematics teachers who use verbs like explain, find evidence, derive formulas, generalize, represent the topic in new ways, deduce, create, suggest, etc., enable students to perform in a variety of thought demanding ways on the topic.

-

From the responses given by participants (see Tables 7 and 9) it became clear that there were a number of factors which influenced participants not to relate their teaching activities to real life situations and engaged students in active and constructive interactions with each other. These included overcrowded classrooms, lack of teaching and learning materials, lack of teaching facilities, lack of sufficient textbooks and others. It is therefore important that good approaches for teaching large classes are developed and that teachers be supported in how to use such approaches effectively.

Table 7 also revealed that participants found it difficult to provide their students with ongoing assessment and feedback, to put students' needs into consideration during the instructional process, to create opportunities for students to evaluate each others' work and to prepare activities that asked their students to think beyond the classroom. Participants indicated various factors and challenges that are discussed later in this chapter. It would therefore be of great benefit to students if assessment occurred throughout the learning process from the beginning of the course to the end and involved feedback from the teacher and from the peers. This would help students make connections between the lesson and the life outside the classroom.

Several authors such as Brooks & Brooks (1999), MEC (1993), Perkins (1993) have indicated that peer teaching and students assessing each others' work are significant approaches to the teaching and learning for understanding that needed more preparation

on the part of the teacher. The above findings are supportive of those by Boder (1998). Boder (1998) explained that teaching and learning are not synonymous, a teacher can teach and teach well without students learning, and how a teacher teaches could be more important than what a teacher taught. It is therefore important that students' life experiences should be valued as a starting point for their learning.

Teachers' knowledge about teaching mathematics for understanding

Tables 4, 5, 6, and 8 showed the teachers' knowledge about teaching mathematics for understanding. The participants indicated that they strongly agreed that it was important to teach mathematics for understanding. It seems that many mathematics teachers supported teaching for understanding, even though evidence from the interviews indicated that teaching for understanding was ill defined by the mathematics teachers (see Tables 4 and 5).

Although it was observed that there were signs of applying some of the instructional approaches that were based on teaching for understanding framework to a certain extent (Table 7), it became clear from the study (see Tables 6 and 8) that some teachers were using approaches based on teaching for understanding framework without being aware that those approaches reflected teaching for understanding. The participants indicated very well how to teach for understanding, but failed to explain how one could tell that a

student had learnt with understanding a mathematics topic (see Tables 5 and 6). It seems that some teachers knew the constructivist theory, but they did not understand the practical part of this theory.

It was argued by Perkins (1998) that if the teaching for understanding framework happened to be well understood by teachers, there would be a guarantee of greater achievement consistently applying the approaches that are based on the teaching for understanding framework.

Table 4 showed that the teaching for understanding was not understood by all the participants. “Who cares about teaching approaches, if students understand or they have just memorise, all they want to see is the results that students are passing” one participant explained. It seems that in many classrooms the goal was to reach the final topic of the mathematics syllabus by the end of the course. It is therefore important that teaching for understanding is well explained to all teachers, what it could offer and how it could be applied in their teaching in order to put it to work.

THE SCHOOL ENVIRONMENT, CLASSROOM ACTIVITIES AND ASSESSMENT THAT SUPPORTED TEACHING FOR UNDERSTANDING

It was assumed that essential materials such as textbooks and syllabi, school rules, overcrowded classrooms and lack of facilities might make it difficult for mathematics teachers to incorporate teaching for understanding in their teaching effectively. It is unlikely that teaching for understanding will occur with the occasional use of hands-on

activities and assessments that support teaching for understanding (Perkins, 1998). It is therefore important that the school environment, classroom activities and assessment support teaching for understanding.

Classroom Environment

As can be seen from Figure 5, there were many factors which hampered participants from actively involving their students in classroom activities that supported understanding. The following were some of the factors, which were given by the participants; Classrooms had broken windows, overcrowded classrooms, classrooms with insufficient or broken chairs and desks, dilapidated classrooms, classrooms without teaching and learning materials displayed on the walls, insufficient textbooks and other teaching / learning facilities. It was further observed that 15% of the participants had to teach while some students were either sitting on desks or standing due to lack of sufficient chairs and desks in their classrooms.

Poor classroom environment, according to Blythe (1994) might make it difficult for teachers to incorporate teaching for understanding in their teaching effectively. Five teachers indicated that their classes could not be locked due to broken windows and doors that left teachers without the option to display posters and other teaching and learning materials on the walls after their teaching. It is therefore important that teaching for understanding classroom environments should be supported by teaching with powerful representations such as visual aids that would help students to solve problems by applying new ideas in different contexts.

Classroom activities, tests and exams

According to Walter, Meredith & Joyce (1996) for students to learn for understanding, classroom activities and tests should encourage students to think beyond what they already know. Table 8 shows the measures taken by the participants to ensure classroom activities that supported students' understanding. Participants indicated the measures that supported teaching and learning for understanding such as encouraging students to derive mathematics formulae, present the content into new ways, and explain their answers. The study findings support those by Berger & Luckmann (1996) who argued that in order to get beyond rote memorization and achieve true understanding, students need to develop and integrate a network of associations linking new inputs to pre-existing knowledge and beliefs anchored in concrete experience.

The same findings are supportive of those by Gardner (1991). Gardner explained that many successful students in the past have not possessed critical thinking, problem-solving, collaborative, and communication skills. More importantly these students have had great difficulty applying their knowledge in new situations. It is important that the schools shift from traditional assumptions about teaching and learning and resemble the real social world where diverse approaches to solving complex problems are recognised.

From the findings presented so far under this heading it is clear that participants found it difficult to teach mathematics for understanding effectively. The findings further reveal the various challenges and problems that the participants experienced during their

teaching of mathematics. The problems and challenges faced by the participants in teaching mathematics for understanding are addressed next.

CHALLENGES AND PROBLEMS FACED WHEN TEACHING FOR UNDERSTANDING

Blythe (1998) revealed that while most teachers agree that the traditional approaches to teaching promote neither the interaction between prior and new knowledge nor the conversation that are necessary for deep understanding, there are also some difficulties accompanying the teaching for understanding approaches.

Identified problems and challenges

From the responses given by the teachers, it is clear that it was not easy to teach for understanding. Table 8 shows that teachers found it difficult to prepare students with tests and classroom activities that offer support to the teaching and learning of mathematics for understanding. Eighteen (50%) of the responses from the participants indicated strategies that were not drawn from the teaching for understanding framework such as asking students to show all the steps that led to the answer(s) and used old question papers. The findings also supported those by Kettle & Sellars (1996) who argued that teachers found it difficult to create experiences for their learners that could connect what they already knew with new experiences.

All the participants (100%) indicated that they experienced difficulties in teaching mathematics effectively due to various problems and challenges. These included poor classroom environments, lack of teaching and learning materials, overcrowded classrooms and the long syllabus. The shortage of chairs and desks, automatic promotion from grade 11 to grade 12, and poor support from parents and communities were also indicated among the challenges faced. Short teaching periods, insufficient textbooks, lack of professional and advisory services, lack of teaching facilities such as photocopying machines and paper as well as students' attitudes towards mathematics were also identified as challenges faced in teaching mathematics for understanding.

It is often argued that learner-centred related teaching methods developed and successfully used in developed countries such as the USA will not work in large classes in Southern Africa (Olivier, 1996). It is therefore important that good approaches for teaching large classes are developed and that teachers be supported on how to use such approaches.

It also emerged from the study that parental involvement in the education of their children was satisfactory (see Table 9). Only one (1.8%) of the participants had experienced poor involvement of parents in their children's education. The above findings are supportive of those by Battista (1994). Battista pointed out that educators should understand that students' learning outcomes must be supported by both teachers and parents. Where the parents are seriously interested in the education of their children,

they can as a group provide tremendous support to the schools by enhancing the learning environments and conditions.

From Table 9, it is clear that participants had experienced various challenges regarding teaching mathematics for understanding. It is therefore important that teachers are trained on how to face challenges such as overcrowded classrooms and lack of teaching and learning facilities / resources that were found to be hindrances to effective teaching and learning.

Measures taken by mathematics teachers to deal with identified problems and challenges that hindered their instructional approaches.

The above identified problems and / or challenges such as the poor classroom environment, lack of teaching and learning materials, overcrowded classrooms, long syllabus, shortage of chairs and desks, automatic promotion from grade 11, and poor support from parents and communities, etc., raised questions on what measures the mathematics teachers should take to deal with the identified challenges.

Figure 6 shows that 55% of the participants gave extra classes as the most frequent measure taken by the mathematics teachers to deal with identified problems that hindered the use of teaching for understanding. Extra lessons may not serve the purpose of teaching mathematics for understanding unless teachers align their instructional approaches with the teaching for understanding framework.

From the study it becomes clear that teaching mathematics for understanding requires a hardworking teacher, dedicated, organized, able to plan ahead, and willing to spend a great deal of extra time in lesson preparation. On the other hand, students needed to spend the larger part of their time with activities that required them to generalize, to find new examples, to carry out applications, and other thought provoking activities that would help them to build understanding.

The study revealed some interesting findings with regard to how the participants dealt with identified challenges in their mathematics classrooms. As can be seen from Table 9 there were challenges such as overcrowded classrooms and insufficient textbooks which hampered mathematics teachers from teaching mathematics effectively. But, on the other hand the participants were found reluctant to approach colleagues to help them deal with the identified problems that hindered their instructional approaches. Only three (15%) of the participants indicated that they had approached other mathematics teachers to help them deal with identified problems that hindered their instructional approaches.

The findings presented so far on challenges and problems faced in teaching for understanding show that many teachers still felt that they could not teach mathematics explicitly for understanding for two important reasons. First change does not happen overnight. Second, it might take time for a teacher and a group of students to learn how to work in a teaching for understanding classroom setup. The findings raise a question of what necessary support mathematics teachers needed in order to deal with the identified

challenges faced in teaching mathematics for understanding. The necessary support(s) are addressed in the next section.

SUPPORT NEEDED TO ENSURE EFFECTIVE APPLICATION OF TEACHING MATHEMATICS FOR UNDERSTANDING

Kettle & Sellars (1996) studied teacher training institutions. They claimed that problems regarding teaching for understanding such as difficulties to prepare students with tests and classroom activities that offered support to the teaching for understanding and difficulties to identify local materials as teaching and learning aids were attributable to the fact that teacher educators also faced similar problems. Figures 6, 7 and Table 9 showed that mathematics teachers needed to be supported in order to cope with the very challenging and demanding approaches of teaching for understanding. It is therefore important that mathematics teachers are prepared for the responsibilities they carry, in order to overcome the challenges posed by the classroom environment, classroom activities and lack of teaching and learning materials during their teaching.

The training received from teacher training institutions regarding teaching for understanding

Figure 7 revealed that 70% (40% and 30%) of the participants were either satisfied or very much satisfied with the training received from teacher training institutions in support of teaching for understanding framework. Only 30% of the participants were not satisfied with the training they had received from their teacher training institutions. One participant explained that her training was more content based and less on methodology.

It is therefore important that new mathematics teachers are provided with the necessary support, models and tools for beginning their teaching careers in order to establish classroom norms that support understanding.

Support needed regarding teaching for understanding

From the responses given by the participants during the interviews (see Table 10), there are a number of types of support and / or training required by teachers to enable them teach mathematics for understanding. Participants identified several types of support and / or training such as induction courses for new mathematics teachers, staff development, mathematics teachers' association such as the Namibian Mathematics and Science Teachers Association (NAMSTA), and in-service training that would help them in this regard.

It also emerged from the interview data (see Table 10) that the majority of the participants required support and further training and /or in-service opportunities in order to be equipped with the necessary skills which would enable them to teach mathematics for understanding effectively. The support regarding the teaching for understanding was also noted by Kinchloe & Steinberg (1993) who were of the opinion that if teachers have to be motivated to teach for understanding, they need to understand why they need the skills and believe in the benefits to be derived from using it.

Some mathematics teachers felt that the In-Service Training and Assistance for Namibian Teachers (INSTANT) Project that was responsible for the introduction of Junior Secondary Mathematics in 1992 needed to be revived to provide training in important areas of the curriculum such as planning classroom activities and assessments.

Table 10 reveals that the induction of new mathematics teachers into the teaching profession was important at the beginning of their careers. These observations support those by Ball (2003) who explained that the beginning teachers rarely made smooth transitions into teaching. Often they were hired at the last moment, left isolated in their classroom, and given little support. Ball further argued that comprehensive induction programmes should provide new teachers with the necessary models and tools for beginning their teaching careers, as well as the mentors and support groups to guide them through curriculum planning. It is important that the induction programmes should be seen as a priority in the Namibian Education System in providing specific guidance aimed at helping new teachers meet performance standards.

The teachers revealed that they needed teaching and learning materials were needed in order to teach for understanding. Due to lack of learning materials some teachers opted to buy from their pocket some of the teaching materials such as posters, metre sticks, glues, and protractors among others in order to create experiences for their students that could connect what they already knew with new experiences. The teachers needed to learn how to identify local materials that could be used as alternative teaching materials. For example making their own metre sticks from wood, protractors from unwanted boxes or

plastics, use discarded boxes as posters and many materials in their environment. It is therefore important to all education stakeholders to give the teachers the education and support that they needed to teach their students to higher standards that the challenges of the 21st century demand.

It also emerged from the interview data (see Table 9) that some participants requested the establishment of an annual regional mathematics conference as a platform where mathematics teachers could meet and debate issues pertaining to the teaching of mathematics in general. Such platforms could create a quality teaching force and introduce new approaches to the teaching of mathematics for understanding. The study findings support those by the Ministry of Education (2005) and the Ministry of Higher Education Training and Employment Creation (MHETEC) (2004), as well as the National Planning Commission of Namibia (2005), that professional development must go beyond the needs of an individual teacher and address the entire school system, in order to ensure students' success in the school.

The interviews identified possible ways in which mathematics teachers might be helped and supported to improve their practice on teaching for understanding (see Table 10). In-service opportunities, training workshops, induction programmes for new teachers, staff development and strengthening mathematics teachers' associations among others, were identified by the teachers as crucial in upgrading individual teachers' instructional approaches. This was believed by the participants that would help mathematics teachers to get a clear understanding of teaching for understanding theoretically and practically.

This argument has been echoed by the MEC (1993) that schools need to set up situations in which understanding can be applied successfully.

This chapter discussed the results of the study. In the next Chapter, the summary, conclusion and recommendations of the study are presented.

CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this chapter the summary, conclusion and recommendation of the present study are given.

Summary

The purpose of this study was to find out the factors as well as the challenges that influence the effective teaching and learning of mathematics for understanding in selected senior secondary schools in the Omusati Education Region. The following five research objectives were addressed:

1) Find out the mathematics teachers' understanding and use of teaching for understanding approaches.

2) Find out the extent to which the mathematics teachers practice the teaching for understanding approaches in their teaching.

3) Find out how the schools in which teachers work and class-work activities, tests, assignments, examinations, etc, for which teachers prepare their students, best support learning mathematics for understanding.

4) Identify factors and challenges encountered by grade 11 and 12 mathematics teachers in the application of teaching for understanding framework and how to overcome these challenges.

5) Explore the necessary support and /or training opportunities that mathematics teachers may need to ensure effective application of teaching for understanding in their regular classroom.

The study was guided by the following assumptions:

1) Teaching/learning activities for which the teachers prepared their learners, might not offer necessary support for teaching for understanding. Consequently, the teachers might not be able to provide mathematics content that is worth understanding if the prepared activities cannot create opportunities for students to make sense of what they are doing and/or can not make connections between what they know and what is being presented.

2) It was assumed that teacher education programmes might not be doing enough to equip student teachers with basic competencies and necessary skills that they may need to enable them cope with the very challenging and demanding approaches of teaching for understanding. In addition to this, many teachers in Namibian secondary schools and in the Omusati Education Region in particular might not know and understand how the teaching for understanding works, hence, they might not incorporate it, in their teaching.

3) It was also assumed that essential materials such as textbooks and syllabi, school rules, overcrowded classrooms and lack of facilities might make it difficult and inconvenient for teachers to incorporate teaching for understanding in their teaching effectively. Most of the school principals, advisory teachers, heads of department,

circuit inspectors and other school management members might not have enough skills about teaching for understanding (Uzat, 1998). As a result, teachers might not be motivated, while very large classes might make it very difficult for teachers to plan activities that support understanding.

4) It was further assumed that some schools might not have sufficient learning resources such as laboratories and libraries to support teaching and learning for understanding. The length of the teaching period per lesson of 40 minutes might be too short since teaching mathematics for understanding requires ample time to teach effectively.

5) It was assumed further that teachers' perceptions that mathematics is a difficult subject might make it difficult for teachers to engage their students in meaningful learning. Since mathematics is an abstract subject by nature, teaching for understanding could only be realized if both teachers and students alike are prepared to share both commitment and responsibility to teach and learn for understanding.

6) It was assumed that teachers might be influenced by the traditional teaching method that could make some teachers feel uncomfortable with the more demanding reflective and challenging teaching for understanding. Consequently teachers might feel that experience was sufficient to improve their teaching mathematics for understanding.

The sample was made up of eight senior secondary schools out of the population of 12 senior secondary schools in the Omusati Education Region. The schools were selected from the school circuits using maximum variation and random sampling techniques. Twenty mathematics teachers from eight selected senior secondary schools in the Omusati Education Region responded to the interviews and two lessons per participant were observed. The data collected were analysed using descriptive statistics. Interviews and observations for mathematics lessons in the selected senior secondary schools in the Omusati Education Region were also used to gather data.

The findings of the study showed that the teachers did not have adequate knowledge about teaching for understanding framework. The teachers gave their perceptions of teaching for understanding from superficial points of view. They did not take into account the difference between understanding and knowing. On the other hand the study revealed that teachers used a variety of teaching approaches such as problem solving, demonstration, chalk and talk, lecture method and others in the teaching of mathematics. It also emerged from the study findings that there were many factors which hampered mathematics teachers from actively involving their students in classroom activities (see Figure 5).

The study also revealed several factors that influenced the teaching and learning of mathematics for understanding. It also became clear from the results of the study that the teachers found it difficult to teach mathematics for understanding due to a number of factors. Some of the identified factors included: overcrowded classrooms indicated by

20% of the participants, insufficient textbooks indicated by 14.8%, lack of teaching and learning resources and lack of support from advisory teachers were indicated by 10.9% of the participants respectively (see Table 9).

Although 70% of the participants were satisfied with the training received from teacher training institutions in support of teaching for understanding framework (see Figure 7), they needed support in order to teach mathematics effectively. The study identified support and / or solutions necessary to address the factors and the challenges that hampered effective teaching of mathematics for understanding. Possible solutions for addressing the situation included; induction courses for new mathematics teachers, staff development, in-service training opportunities, training workshops, professional development programmes and advisory teachers support services.

The findings of the study are in accord with the views of Blythe (1994) who noted that, to ensure the realization of teaching mathematics for understanding, the departure point should be the training of the teachers on the teaching for understanding framework. Both theoretical and practical experiences during pre-service and in-service teacher training should be taught. It also emerged from the study that if teaching for understanding had to be realized in the Namibian Education System, teachers should also be prepared to avoid traditional teaching approaches and put students at the centre of the teaching and learning process.

Conclusion

The study investigated the factors and challenges that hindered the effective teaching of mathematics for understanding. This study has revealed that some teachers in Namibian classrooms found it difficult to teach mathematics for understanding. Even though teachers found it difficult to teach mathematics for understanding, they supported teaching for understanding as an effective tool for the teaching of mathematics. It is therefore important that teachers are provided with more training opportunities such as induction courses, in-service training programmes, training workshops and support services in order to deal with the identified challenges faced in teaching mathematics for understanding.

Ball (1994) believed that if teaching for understanding could be understood by mathematics teachers, there would be a remarkable improvement in applying it practically during their teaching. From the overall results of this study, it seems that teaching for understanding might be realised if all the stakeholders in Education worked together to equip teachers with the necessary skills and the support needed to practice teaching approaches that supported understanding.

Teaching for understanding is very important. The perception of some teachers that their roles in teaching were to just ensure that the syllabus was finished is unfortunate. The teaching for understanding should be seen by teachers as an important tool for helping students to grasp the significance of what they were learning. Hence understanding must rank far up on the short list of priorities on the agenda of the Ministry of Education in Namibia.

Recommendations

In view of the findings reported in this study, the following recommendations were made, directed at mathematics teachers in the Omusati Education Region, the Ministry of Education and other relevant stakeholders in Education in Namibia.

1. Teaching for understanding should be practiced in the mathematics classrooms. This can be done through making learning a long-term thinking centred process, by providing students with rich ongoing assessments and feedback opportunities, and by supporting learning with powerful representations. This could ensure that mathematics teaching enhances each student's personal development, understanding the world around them and expansion of each student's career options.

2. Mathematics learning should aim at active use of knowledge and skills so that students can put them to work in assessment, tests, examinations and professional roles. These require teachers to be coaches for their students by involving them in learning by doing, through enquiry, discovery, active observation and demonstration.

3. In order to effectively practice the teaching for understanding framework, teachers should be provided with proper training on how the teaching for understanding can be related to the curriculum, the value it can offer and how it can be effectively applied in their instructional approaches.

4. The new teachers should be provided with induction programmes to give them support and tools for beginning their teaching careers, as well as the mentors to guide them through curriculum planning. During the first year of teaching, schools, and the Ministry of Education officials should focus on assisting and supporting new teachers rather than simply assessing their work.

5. The Ministry of Education should continue with organizing in-service training, workshops and seminars in order to improve the teaching and learning for understanding. Regular advisory services from subject specialists should be enforced to give support to teachers who might be experiencing difficulties in teaching for understanding of some mathematics topics in the school syllabus.

6. The Ministry of Education should address issues such as overcrowded classrooms that hinder effective teaching for understanding. The policy on teaching norms, teacher-to-learner ratio of 1:35 should be revised, particularly at senior secondary level in order to reduce overcrowded classrooms and thereby realize the effectiveness of the teaching for understanding approaches.
7. Factors such as lack of teaching resources, short teaching periods of 40 minutes, automatic promotion, poor classroom conditions and others should be addressed by the Ministry of Education and all stakeholders in Education to create a conducive classroom environment in Namibian senior secondary schools that will encourage students to learn for understanding. Out dated content that encourages rote learning and creation of negative attitudes amongst students towards mathematics should be de-emphasised.

8. The Directorate of National Examinations and Assessment (DNEA) and the National Institution for Education Development (NIED) need to set up assessment procedures that support teaching for understanding in Namibian schools. Current assessment procedures do not support the purpose of teaching for understanding.

9. Teachers should make understanding goals and / or lesson objectives public to students in order to create focus for students to reach the learning objectives that teachers want them to reach.

10. Further research of the same kind should be conducted in other school subjects at all school levels and teacher training institutions in Namibia to ensure the realization of teaching for understanding approaches across the curriculum countrywide.

REFERENCES

Ball, D. L. (2003). **With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics**. East Lansing: Michigan State University.

Ball, D. L. (1994). Teaching, learning and the mathematics reforms: What do we think we know and what do we need to learn? **Phi Delta, Kappan**, 11 - 23

Baron, J. (1990). **Performance assessment: Blurring the edges among assessment, curriculum, and instruction**. New York: Academic Press.

Battista, M. T. (1994). Teacher Beliefs and the Reform Movement in Mathematics Education**. Phi Delta Kappan**, 462 – 470.

Berger, P. L. and Luckmann, T. (1996). **The Social Construction of Reality**: A Treatise in the Sociology of Knowledge. New York: Garden City Publishers.

Berger, P. L. and Luckmann, T. (1966). **The Social Construction of Reality**. New York: Garden City Publishers.

Best, J. W. & Kahn, J. V. (1998). **Research in Education.** California, Bacon & Allyu Publishers.

Blythe, T. (1998). **Teaching For Understanding with New Technologies.** San Francisco: Jossey-Bass.

Blythe, T. & Perkins, D. (1998). **Understanding understanding.** San Francisco: Jossey-Bass.

Blythe, T. (1994). **Putting Understanding Up Front.** Teachers Education: A Deeper Look at Teaching for Understanding 51 (5), 1 – 15

Boder, G.M. (1998). Constructivism: A Theory of Knowledge. **Journal of Chemical Education.** 63 (10), 873 – 878

Borg, W. R., Gall, J. P. and Gall, M. D. (1996). **How to design and evaluate research in Education.** 3rd Ed. New York. McGraw-Hill.

Brooks, J. G. & Brooks, M. G. (1999). **In search of understanding**. **The case for Constructivism classroom.** Alexandria: Association for Curriculum Development and Supervision.

Brooks, J. G. & Brooks, M. G. (1990). **The Case for Constructivist Classroom**. Alexandria, Virginia: Association for Curriculum Development and Supervision.

Brophy, J. (1992). Probing the Subtleties of Subject-Matter Teaching. Educational Leadership**. Phi Delta Kappan**, 4-8.

Burns, M. (1994). Arithmatic: The Last Holdout. **Phi Delta Kappan**, 471 – 476.

Cohen, C. (1994). **Administrative Education in Namibia: The colonial period to the present**. Windhoek: Namibia Scientific Society.

Coombs, B. (1995). **Successful Teaching: A Practical Handbook**. Ibadan: Heinemann Educational Books Ltd.

Freire, P. (1998). **Pedagogy of Freedom: Ethics, Democracy, and Civic Courage.** Lanham: Rowman & Littlefield publishers.

Gardner, H. (1991). Teaching for Understanding Within and Across the Disciplines. **Education Leadership**, 14-18.

Johnson, B. & Christensen, L. (2004). **Educational research**. **Quantitative, Qualitative and Mixed Approaches.** Boston: Pearson Education, Inc.

Kettle, B. & Sellars, N. (1996). The Development of Student teachers Practical Theory of Teaching. **Teaching and Teacher Education**, 81, 15 – 27

Kinchloe, J. L. & Steinberg, S. R. (1993), Tentative Description of Post-Formal Thinking: The Critical Confrontation with Cognitive Theory. **Harvard Educational Review**, 296 – 320.

Kickbusch, K. (2000). **Teaching for Understanding: Educating Students for Performance.** http:www.weac.org/resource/under.htm (access date: 18 August 2006).

MBESC (1996). **Report on the evaluation of Education Reform Advisory (ERA) Project**. Windhoek: Namprint.

McMillan, J. H. & Schumacher, S. (2001). **Research in Education**. Madrid: Addison, Wesley Logman, Inc.

McLaughlin, W. & Rowan, B. (Fall 1993). Understanding Context Effects on Secondary School Teaching. **Teachers College Record,** 45 – 68.

MEC (1993). **Towards Education for All: A Development Brief for Education, Culture and Training**. Windhoek: Gamsberg Macmillan.

MHETEC (2004). **Ministry of Higher Education, Training and Employment Creation Annual Report.** Windhoek: Namprint.

MOE (2005). **Education and Training Sector Improvement Programme (ETSIP) Phase I (2006-2011).** Windhoek: Namprint.

National Planning Commission of Namibia (2005), **Annual Report on Second National Development Plan (NDP2) 2005.** Windhoek: Printech.

Olivier, A. (1996). Teaching Large Classes. **Association of Mathematics Teachers of South Africa (AMESA) Newsletter.** 8(8), 7 – 9.

Perkins, D.N. (2002). **Professional standards for teaching mathematics**, Reston, Virginia. National Council of Mathematics Teachers (NCTM).

Perkins, D.N. (1998). **Understanding Teaching for Understanding**. San Francisco: Jossey-Bass.

Perkins, D.N. (1996). **Smart schools: From training memories to educating minds.** New York: The Free Press.

Perkins, D.N. (1993). Teaching for Understanding. **The Professional Journal of the American Federation of the teachers**, 17 (3), 28 - 35.

Perkins, D.N. (1992). A new look in representations for mathematics and science learning. **Review of Educational Research**, 58 (3), 303-326.

Perkins, D.N. (1988). Teaching for Transfer. **Educational Leadership,** 46 (1), 22-32.

Schrenko, J. (1994). **Structuring a Learner School**. Victoria: Hawker Brown Low Inc.

Seizer, T.B. (2000). **Horace's compromise: The dilemma of the American high school today.** Boston: Houghton Mifflin.

Steinberger, E. D. (1994). Howard Gardner on Learning for Understanding. **The School Adminstrator**, 26 – 29.

Tiberghien, S. (2000). **Designing the Teaching situations in the Secondary Schools**. Buckingham: Buckingham Colleges of Education Inc.

Uzat, S. L. (1998). **Cognitive coaching and self-reflection: Looking in the mirror while looking through the window**. Paper presented at the annual meeting of the Mid-South Educational research Association, 7th July 1998. New Orleans.

Walter, R. B., Meredith, D. G. & Joyce, D. (1996). **Teaching Mathematics with Understanding to Limited English Proficient Students.** Madison: University of Wisconsin-Madison Inc.

Wiske, M. S. (2005). **What is teaching for understanding?** San Francisco: Jossey-Bass.

APPENDICES

APPENDIX 1. INTERVIEW PROTOCOL

The following questions seek mathematics teachers' opinions with regard to teaching mathematics for understanding. I pledge total confidentiality to all responses. Please note that your response to the interview protocol is not compulsory. Except for the researcher **no** individual, such as colleagues, Principal, Education Officer, or the Regional Director will have access to the responses. When the data processed, the interview records and observation checklists will be destroyed.

Section A: Biographic data of the interviewee

1. Name of School ……..

2. Your sex: Male Female

3. Your age ☐ Years

4. What are your current teaching subject(s)?
   Mathematics only
   Mathematics and other subjects (specify) …….

5. What grade(s) are you teaching?
   Grade 11 Grade 12 Grade 11 & 12

6. What is your teaching experience in years?
   0 – 2 yrs 3 – 4 yrs 5 – 6 yrs 7 – 8 yrs 9yrs and above

7. What are your teaching qualifications?
   Grade 12 + 3yrs teaching diploma
   Grade 12 + 4yrs teaching diploma
   Grade 12 + Bachelor Degree in Education
   Grade 12 + B degree + Postgraduate diploma in Education
   Others (specify): ……..

Section B

To determine whether mathematics teachers apply teaching for understanding approaches in their teaching.

1. Understanding in mathematics teaching and learning is very much important.
   - strongly disagree
   - disagree
   - neither agree nor disagree
   - agree
   - strongly agree

2. In the context of teaching and learning mathematics, what does teaching for understanding mean to you?
   ...……...……
   ……

3. Why do we need to teach for mathematics understanding?
   ……
   ……
   ……

4. How can you tell that a student has learned with understanding a mathematics topic?
   ……
   ……
   ……

5. How can one teach mathematics for understanding?
   ……
   ……
   ……
   ……

6. Teachers use different approaches in teaching. What approaches do you use often in teaching your lessons?
   ……
   ……
   ……
   ……

7. Why do you use this / these teaching approaches?
   ……
   ……
   ……

8. Do you think these instructional approaches are serving the purpose of teaching mathematics for understanding? Yes No. Give reasons for your answer.
……
……
……
.....
.....
.....
.....

Section C

To determine how the school in which teachers work and teaching activities which teachers use to prepare their students, can best support teaching mathematics for understanding.

9. Do you think your school environment such as seating arrangements, physical conditions, availability of visual aids, etc, is supporting teaching / learning mathematics for understanding? Yes No. Give reasons to support your answer.
……
……
……

10. How do you ensure that your classroom activities, tests, and exams help students to develop understanding in mathematics?
……
……

Section D

To determine factors and challenges encountered by mathematics teachers when applying the teaching for understanding framework.

11. Do you find it difficult / easy, to teach mathematics for understanding using the mentioned approaches in section B? Yes No
12. What factors do you think make it difficult / easy, for you to apply teaching approaches that support understanding? ……
    ……
    ……

13. If you find it difficult to teach mathematics for understanding with these approaches, how do you deal with the identified difficulties in your classroom?
    ……
    ……
    ……

Section E

To establish necessary support and training required for teachers regarding teaching mathematics for understanding.

14. The training you have received from teacher-training institution(s) helped you to teach mathematics for understanding?
    strongly disagree
    disagree
    neither agree nor disagree
    agree
    strongly agree

15. What support and / or training do you need to ensure effective application of approaches for teaching mathematics for understanding?
    ……
    ……

16. Do you have any comment(s), suggestion(s), or contribution(s) to add? ……
    ……
    ……
    ……

APPENDIX 2. OBSERVATION CHECKLIST

To evaluate whether mathematics teachers apply teaching for understanding approaches and the extent to which they practice them in their teaching.

School ……..…… Grade ……..
Sex …… Topic: …….

Observation of interactions between the teacher and students during classroom instructions:

No	Description of behavior(s) observed	Yes	No
1.	the teacher uses activities that make understanding a more central and reachable objective(s) in his / her class		
2.	the teacher uses teaching activities that draw on the teaching for understanding framework		
3.	the teacher uses verbs such as: explain, find evidence, derive formulas, generalize, represent the topic in new ways, deduce, create, suggest, etc , in the lesson objectives		
4.	the teacher allows students to interact constructively with one another in building and integrating new knowledge from experiences		
5.	the teacher teaches explicitly and allows students to make connections to meaningful contexts outside the classroom		
6.	the teacher encourages all students to actively participate in their own learning process		
7.	the teacher provides students with rich ongoing assessments and feedback that foster understanding of mathematics		
8.	the teacher encourages students to think beyond what they already know		
9.	the teacher puts the students' needs into consideration		
10.	the teacher allows the students to evaluate each others' work		
11.	the teacher encourages students to learn by doing through enquiry, discovery, observation and demonstration		
12.	the teacher instructs students to engage in thought provoking activities		
13.	the teacher asks questions that they answer themselves		
14	the teacher seeks elaboration of learners' initial responses		

…END…

APPENDIX 3. PERMISSION LETTER TO OMUSATI EDUCATION DIRECTOR

Mr. Tobias Amoonga 409 Xamigaub Street, Cimbebasia, P.O.Box 6627, Ausspannplatz, Windhoek, Namibia, Tel: 061-2933195, Fax: 061-2933913

May 22, 2007

The Director: Omusati Education Region
P / Bag 2020, Ondangwa, Tel: 065-242500 / 242566, Fax: 065-241615

Re: Seek permission to carry out a study in the Omusati Education Region

I' m Tobias Amoonga hereby seek permission to carry out the research study in your Education Region. The study will be conducted for the dissertation in partial fulfillment for the Masters of Education Degree of the University of Namibia which must be completed this year 2007.

The main objective of the study is to find out the factors as well as the challenges that influence the effective teaching and learning of mathematics for understanding in Senior Secondary Schools (grades 11 & 12) in the Omusati Education Region. The Omusati Education Region was chosen due to the fact that most of the educational studies in the faculty were conducted either in town or areas close to Windhoek. It is against this background that I would like to conduct this study in remote areas such as Omusati Education Region.

The following senior secondary schools were selected as sample schools: David Sheehama; Negumbo; Nuujoma; Okalongo; Onesi; Shaanika Nashilongo; Shikongo Iipinge and Ruacana Vocational. Upon permission granted, I am humbly requesting your office to inform the Principals of sampled schools about my study. The study will be conducted during the week of 09 July 2007 up to 27 July 2007.

The study is significant to mathematics teachers to improve their own teaching practices, teaching approaches, as well as setting of assessment tasks that support teaching and learning for understanding. I pledge total confidentiality to all responses, and the final results will be made available to the public.

Thank you for your kind attention that you will accommodate me in your tight schedule in order to improve teaching and learning mathematics for understanding in Namibian schools.

Sincerely
T. Amoonga
UNAM M.Ed Student (Education Officer: MoE Head Office)

APPENDIX 4. PERMISSION LETTER FROM THE OMUSATI EDUCATION REGION DIRECTOR

REPUBLIC OF NAMIBIA
MINISTRY OF EDUCATION
OMUSATI REGION

Tel: (065) 242518
Fax: (065) 241615

Private Bag 2020
ONDANGWA
NAMIBIA

July 4, 2007

Enq: Mrs Loide Shatiwa
Ref:

To: Mr Tobias Amoonga
409 Xamigaub Street
Cimbebasia
PO Box 6627
Ausspannplatz

Dear Sir

RE: PERMISSION FOR PROJECT RESEARCH STUDY IN SCHOOLS IN OMUSATI REGION

Permission is hereby granted to you to carry out your research study in the following schools: David Sheehama, Negumbo, Nuuyoma, Okalongo SS, Onesi SS, Shaanika Nashilongo, Shikongo Iipinge and Ruacana Vocational Centre. Mathematics remains one of the crucial subjects in the Region, therefore it is hoped that the research findings would be made available to Omusati Regional Office for future perusal and improvement purposes.

Sincerely yours,

MR. LAMEK T. NAFIDI
REGIONAL DIRECTOR

MINISTRY OF EDUCATION
OFFICE OF THE DIRECTOR
2007 -07- 04
REPUBLIC OF NAMIBIA

Cc: The Principals and Inspectors of Education

APPENDIX 5. OMUSATI EDUCATION REGION MAP