

**THE USE OF CONSTRUCTIVISM IN TEACHING MATHEMATICS FOR
UNDERSTANDING**

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Introduction

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 (MEC)(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 Programme leading to the International General Certificate of Secondary Education (IGCSE) and its variant 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 by many reasons. According to MEC (1993) and MBESC (1996), the Cape Education System had a number of discrepancies. First, it was inefficient in terms of low progression and achievement rates. Examinations were typically discriminatory, i.e., norm-referenced, rather than criterion-referenced. 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).

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.” However, the introduction of the (H)IGCSE raised fears, doubts and questions in many of the teachers on how they would best provide effective instruction to their students. In addition, the (H)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.

Freire (1998) 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 suggests 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).

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 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, among others. 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). 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 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. 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. In addition, 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.

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. It was against this background that this study was carried out. Particularly, it sought to find out challenges that hindered effective teaching of mathematics for understanding in the senior secondary schools in the Omusati Education Region.

Purpose of the study

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 how the participants dealt with identified challenges in the 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.

Questions of the study

The following *three* research questions were addressed:

1. What factors and challenges are encountered by grade 11 and 12 mathematics teachers in the application of teaching for understanding framework?
2. How do the participants deal with identified factors and challenges in their mathematics classrooms?
3. What are the necessary support and/or training opportunities that mathematics teachers need to ensure effective application of teaching mathematics for understanding in their regular classrooms?

Literature review

Blythe (1994) supported the 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 (Perkins, 1998).

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 found it difficult to create experiences for their learners that could connect what they already know with new experiences. Kettle & Sellars' (1996) 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). In other words, 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 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.

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 as some of the factors hindering teaching of mathematics for understanding.

Methodology

The study was descriptive in nature. 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.

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 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.

RESULTS AND DISCUSSION

The findings of this study are presented in this section of this paper.

Table 1 presents the challenges faced by teachers in teaching mathematics for understanding.

Table 1: 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

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.

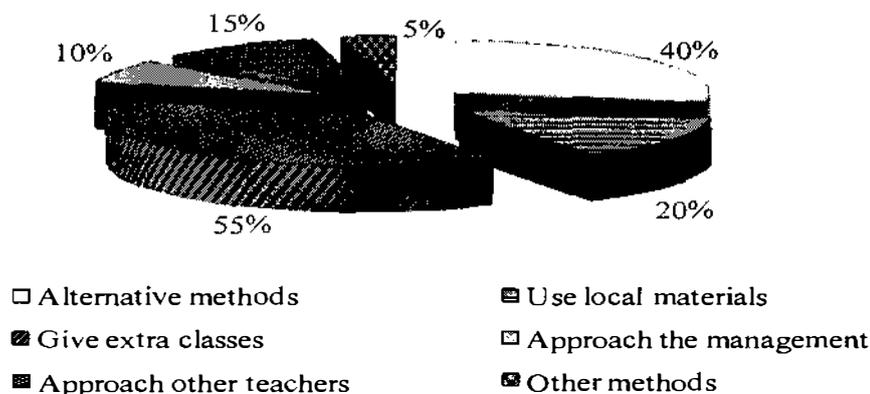
It is often argued that learner-centred related teaching methods developed and successfully used in developed countries such as the USA will not work in large classes in Southern Africa (Olivier, 1996). It is therefore important that good approaches for teaching large classes are developed and that teachers 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 1). 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 1, 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.

Figure provides information regarding what the respondents did to overcome the identified hindrances.

Figure 1: How the participants dealt with identified challenges in their mathematics classrooms (N=20)



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 these identified challenges.

Figure 1 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 became 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 1 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 environment. 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 and are given in Table 2.

Table 2: 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.

From the responses given by the participants during the interviews (see Table 2), 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 (Table 2) 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 2 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 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, 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 levels that the challenges of the 21st century demand.

It also emerged from the interview data (see Table 2) 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 2). 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.

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. 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.
2. 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.
3. 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.
4. 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 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.
5. 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.
6. 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.
7. 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.

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