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Content Mastery of Mathematics in Namibian Secondary Schools

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1. Introduction

The Ministry of Basic Education and Culture in conjunction with the University of Namibia and the European Union introduced the Mathematics and Science Teacher Extension Programme (MASTEP) at the University of Namibia in 1999. This programme recruits qualified junior secondary mathematics and science teachers. The focus of the programme is among other things, on strengthening content knowledge of MASTEP teachers, in order to enable them to teach effectively at the senior secondary level.

According to a needs assessment that was carried out prior to the implementation of the programme, subject content should take high priority. Some of the major concerns for emphasizing the improvement of teachers' understanding of content included the lack of discussion and identification of common student misconceptions or mistakes, and content misunderstanding on the part of the teacher.

2. Area of research

This study focuses on the Mathematics and Science Teachers Extension Project (MASTEP) teachers and their learners. It seeks to answer the following questions:
In which concepts do mathematics teachers exhibit incorrect understanding?
How do these teachers seek to identify students' misconceptions and how are these addressed?
How do these teachers evaluate the identified misconceptions and whether they have been resolved or not?

3. Literature Review

Misconceptions in mathematics are described in different ways by researchers (Graeber 1991, Bell 1982, Hiebert 1984). For the purpose of this study misconceptions are defined as 'alternative conceptions' or knowledge that compares poorly with scientific perceptions (Cobern 1993).

During their training MASTEP teachers are exposed to two ways of dealing with students' misconceptions, namely (i) cognitive conflict and (ii) a cognitive constructivist approach. These strategies are both based on Graeber's (1991) ideas that just telling the learners what is wrong and what is correct is not as effective as when they find out for themselves this information.

Common errors or procedural 'bugs' and misconceptions are taken as the strongest evidence for the constructive nature of knowledge acquisition (Hatano, 1996). Hatano observed that misconceptions are invented by learners (teachers included), through their attempts to make sense of their limited experience. However, Hatano mentioned that most knowledge students have, has been learned from other people. Accordingly, long lasting learning will only take place if learners themselves reject their own misconceptions. This can be achieved when these learners' misconceptions are challenged with evidence that supports correct mathematics. This is called cognitive conflict.

The cognitive constructivist approach to teaching and learning is based on the assumption that learners actively construct their own knowledge from their experiences (Hiebert, 1984). One way of making use of learners' experiences is through group work. Groups help ensuring that learners' correct and wrong ideas are brought out and subjected to challenge and criticism in a non-threatening situation. The class discussion exposes a wide range of ideas and also ensures that if any group has agreed on a wrong answer this can be challenged either by the other groups or the teacher. The whole idea is that the learners reach a correct conclusion based on their own ideas and not take ideas from the teacher.

Just as constructivism can be used to explain how students make sense of their experiences in discussions or small group problem-solving (Tobin and Tippins 1993), so too, constructivism can be used to explain the relationship between how teachers deal with students' misconceptions and teachers' mastery of mathematics content. Constructivism is about what a student constructs and how it compares with the epistemological truth of mathematics.

Tobin and Tippins mentioned that our knowledge of a concept is both individual and social, and through negotiations, agreement is reached. Hence, teachers' failure to identify learners' misconceptions does not necessarily mean that teachers are not knowledgeable in the subject. It might be an indication that teachers either have the same misconceptions or that they lack didactic or methodological know-how to explain fully their subject content to their learners.

Some of the differences between procedural and conceptual knowledge in mathematics, as summarised by Haapasalo & Kadijevich (2000), include:

> Procedural knowledge is rich in algorithms for completing tasks but is lacking in relationships, whereas conceptual knowledge is rich in relationships but is lacking in algorithms for completing tasks (Hiebert & Wearne, 1986).
>
> Procedural knowledge denotes knowledge of procedures and mastery of computational skills, whereas conceptual knowledge relates to knowledge of various interconnections between conceptions that give meaning to mathematical procedures (Shimizu, 1996).

In this study, both cognitive conflict and the constructivist approach formed the framework for analysing the data collected from the respondents.

4. Methods

Data on content mastery and arising misconceptions were collected in 7 mathematics lessons at grade 11 or 12 levels in 4 secondary schools. The sample included rural and urban schools. All teachers were qualified for teaching junior secondary mathematics, but some were teaching senior secondary classes due to lack of adequately prepare and qualified teachers to teach at this level. Three data collection methods were used; audiotape, a non-participatory observer used an observation schedule, and lastly copies of handouts, worksheets, lesson plans, and description of any materials uses in the class. The validity of the data was improved by triangulating the three data sources.

Procedure of the round table

Transcript excerpts from the various lessons will form the basis for analysis for indications of:

- identifiable common errors, procedural bugs and misconceptions as exhibited by teachers and their students
- levels of procedural and conceptual learning of students
- alternative ways of identifying misconception (e.g. through diagnostic tests) may

be discussed as a comparison.

This part of the round table intends to result in criteria for classifying classroom interactions as indicators of common errors, procedural bugs or misconceptions. It should also lead to the formulation of criteria for judging classroom episodes for the emphasis in interactions for reinforcing procedural or conceptual knowledge.

2. Specific excerpts will be used to identify and label different ways of teacher response to

misconceptions exhibited by students
instances when students indicate to changing from procedural learning to conceptual learning, and *vice versa.*

This part of the round table intends to result in identification mechanisms of critical instances in teacher response to content learning needs of their students.

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