THE ROLE OF ETHNOMATHEMATICS AND REFLECTIVE LEARNING IN MATHEMATICS EDUCATION IN PAPUA NEW GUINEA

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Introduction

It is argued by a number of mathematics educators around the world that the mathematical knowledge, ideas and intuitions developed by a specific cultural group are largely ignored by the current mathematics curriculum found within their respective education systems. This situation is particularly apparent within the teaching/learning process whereby such mathematical knowledge developed by children and derived from pre-school experiences within their own environment is most often ignored during the teaching of formal mathematical concepts. This conduct is based on the dominant assumption that the only mathematics that children come to know is what they learn in school. In particular, Masingila (1993) has argued that the acquisition of knowledge in school all too often grows out of a 'transmission' paradigm of instruction and is largely devoid of meaning, that is to say that there is a lack of context, relevance and specific goal during the process of acquiring such knowledge. In other words, mathematics teaching in schools places too much emphasis on the transmission of procedures rather than on the teaching of meaning, thereby discouraging children from bringing their intuitions to bear on school learning tasks (Resnick, in Masingila 1993).

The above situation causes far-reaching negative educational effects for mathematics education in PNG in terms of having a ripple effect on all facets of the teaching-learning process, starting from teacher education activities down to actual classroom activities at the elementary school level. These negative educational outcomes have also been highlighted by research evidence from a number of studies (e.g. Adetula 1990; Clarkson 1992; Lancy 1983; Lean, Clements and del Campo 1990; Saxe 1982; Souviney 1983) which have cited language, culture and learning modality as the three key factors contributing to the mathematics learning

difficulties experienced by many students who come from diverse cultural backgrounds. In particular, the research evidence not only shows that much mathematical misunderstanding has occurred as a result of the kind of teaching practices adopted, but also shows how little understanding is achieved, even in situations where correct answers are given (Matang 1996). This situation applies with force to the case of PNG, where past and present mathematical learning difficulties experienced by many students reflect underlying problems existing in many mathematics classrooms.

Ethnomathematical Practices

Mathematics is a product of culturally based human social activities (Bishop 1991b; D'Ambrosio 1990, 1991) and all societies have developed mathematical practices that are considered most appropriate to their daily lives and cultures. These systems are referred to as ethnomathematics. These cultural practices include jargons, codes, symbols, myths and specific ways of reasoning and inferring (D'Ambrosio 1990,1991) and may involve one or more of the 'universal' mathematical activities of counting, locating, measuring, designing, playing and explaining (Bishop 1991a). PNG, with a staggering cultural diversity of more than 800 different languages, is no exception, since such a rich cultural environment has the potential to not only enhance further knowledge development, but at the same time form contrasting situations for meaningful and reflective learning to occur. It is, however, important to note that one of the key features of these cultural practices is that, in nearly all cases, they depend on the *contextual* reality to provide the necessary *conceptual* meaning of many of the mathematical concepts formally taught in schools, rather than depending on abstraction which tends to characterise many of the 'western' thoughts.

An example which highlights the importance of contextual meaning can be found in the lack of representation of the concept of zero in many of PNG's numeration systems (Matang 1996). There is a logical appeal in this, in that if a person fails to at least touch an object, then no further discussion takes place on it. Thus it is no surprise to find

that many PNG students experience difficulties understanding the presentation, within the formal classroom situation, of abstract mathematical knowledge, such as the concept of zero, in the absence of its relevant contextual meaning.

The Role of Reflective Learning in Mathematics Education

According to Wheatley (1992), reflection plays a critically important role in mathematics learning; just completing tasks is insufficient. Sigel's view (cited in Wheatley 1992) is that reflection in mathematics learning involves distancing oneself from the action of doing mathematics, whereby second-order schemes are constructed. It is one thing to ask a person to solve a problem, but it is quite another thing to ask the same person to take their own action as an object of reflection. Persons who reflect have greater control over their thinking and can decide which of several paths to take, rather than simply being in action.

Moreover, there are also serious limitations of the currently used 'explain-practice' method of instruction in that students do not easily give meaning to abstract formulations which are not in their experience, mainly because of the way in which mathematics is viewed by many as a formal system to be learned in the abstract and then 'applied to the real world' (Masingila 1993; Sigurdson and Olson 1992; Wheatley 1992). To learners, new experiences become more meaningful only if they are related to previous experiences. Thus, in order to enable students to construct a mathematical world which is coherent and useful, mathematics instruction should begin with situations from which generalisations can be made. Mathematical formulations should flow from meaningful experiences rather than beginning with abstract formulations and then applying them to 'real world' problems.

An Alternative Approach to Mathematics Teaching

It seems logical to suggest that there is a strong connection between what is found in the formal school system in terms of the current teaching practices in mathematics and the learning difficulties experienced by many PNG students. This calls for an alternative approach to

mathematics education in PNG in terms of underlying philosophy, the type of curriculum, and the type of teaching practices employed within the context of the classroom. One way of addressing the above problem is to adopt a more interactive and reflective mathematics teaching approach, based on the learner's own sociocultural background. This will not only provide the students with the necessary contextual meaning for understanding the conceptual meaning of many abstract mathematical concepts, but at the same time portray mathematics as a meaningful, attractive and reflective subject, thereby developing critical thinking in mathematics (Matang 1996). In other words, it is strongly suggested that reflective teacher-student interactions should characterise all formal mathematics classroom activities in PNG. This can be achieved by using examples, illustrations, experiences and problem-centered learning situations found within the student's own sociocultural environment. According to Wheatley (1992), establishing an environment which encourages reflection is a complex exercise because, apart from selecting relevant tasks, the teacher must also negotiate social norms in which students can become a community of inquirers. This will apparently require both the students and teacher to learn to talk mathematics and to listen to each other. As argued by Wheatley (1992: 539) effective mathematics instruction:

- promotes autonomy and commitment;
- is based on theoretical models of children's mathematics learning;
- has 'sense-making' as a goal;
- involves the negotiation of social norms; and
- encourages and facilitates reflection.

The above prescription can also be seen as one way of providing accountability to the general public, particularly considering the time and other resource allocations required by mathematics within the formal education system.

Implications for Teacher Education

There are basically three key areas at the teacher level where such an approach will have implications: the role of the teacher; teacher beliefs

and values; and teacher background knowledge (Matang 1996).

Of the three areas mentioned, defining the role of a teacher is probably the most difficult one, but at the same time it is considered one of the most crucial factors in the successful implementation of any curriculum change.

In the light of the reflective and interactive teaching approach envisaged, this is a fundamental issue, in that such an approach to mathematics education will not only require a change in one's underlying views concerning mathematics teaching, but also requires a redefining of the role of a teacher within the classroom environment. In other words, it requires a teacher to change from being an 'authority' and 'transmitter' of knowledge to being a 'facilitator' in the teaching/learning process.

Secondly, teacher beliefs and values concerning the role and nature of mathematics in society are also an important factor. The current mathematics teaching approach, because of its emphasis on the acquisition of skills involving learning of rules and procedures, most often results in teachers adopting the 'expository' teaching method.

The final implication relates to teacher content knowledge in mathematics. Though this may not appear to be consistent with what is being envisaged, if teachers are to be successful in effectively employing the reflective and interactive teaching approach, it is necessary that they be given every opportunity to do an in-depth and reflective investigation of mathematical content knowledge during their initial teaching training. This will inevitably require mathematics teacher educators also to change their current view and teaching approach. This will enable them to adopt and design mathematics teacher training programs that are characterised by reflective teacher/student interactions with emphasis on critical analysis of mathematical knowledge through the use of projects and critical investigative work (Matang 1996). It is only then that mathematics education in PNG will be seen to be not only fulfilling its educational obligation to the learners, but simultaneously achieving the objective of producing a

mathematically literate PNG society.

Conclusion

The current 'explain-practice' method of instruction has negative educational outcomes for mathematics education in PNG in that it does not effectively enable learners to meaningfully construct mathematical relationships. This situation is mainly a result of mathematics teaching done in the absence of the contextual meaning associated with many of the formal mathematical topics taught in schools. An alternative teaching approach, underpinned by reflective learning as its central theme, is therefore suggested, using examples, illustrations and experiences from the learner's own sociocultural environment. Such an approach should not only promote self-esteem on the part of the learners, but at the same time portray mathematics as a meaningful, attractive and above all, a reflective subject.

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