Directions: Journal of Educational Studies Vol 24 (1) June 2002

The Role of Ethnomathematics in Mathematics Education in Papua New Guinea: Implications for mathematics curriculum

Rex Matang

The mathematics learning difficulties experienced by many school students in Papua New Guinea (PNG) under the current mathematics curriculum, which draws heavily on western, mainly Australian models, is well known. Based on a literature review of research on ethnomathematics and mathematics education, this paper proposes an integration of ethnomathematics into the formal mathematics curriculum as one way to address these learning difficulties. This proposal assumes that learning mathematics is more effective and meaningful if the teaching of mathematics begins with familiar learning situations, i.e. teaching from the known to the unknown, utilising the familiar mathematical practices found in the learner's own socio-cultural environment.

Introduction

It is not uncommon to hear many Papua New Guinean students at all levels of the national education system commenting that they have always found mathematics a difficult subject to understand. Depending on the type of cultural background that one comes from, and how well one attaches to mathematics as a formal school subject, there will surely be a variety of responses to this comment given by different individuals. Some would ignore it, probably regarding it as one of the day to day complaints about the experiences children go through. However, for those who seriously call themselves mathematics educators, such a comment constitutes a challenge to their professional competence.

This paper aims to bring to the attention of everyone involved in the business of education services the need to address this situation

head on, because ignoring it would mean several scenarios. Firstly, inadequate numeracy skills can easily be interpreted by many concerned individuals as evidence of professional negligence. Secondly, on a more serious note, are the far-reaching implications such inadequacy would have for a society where everyday existence and survival depend heavily on numeracy as an important cultural tool. While there are many other factors that may have contributed towards students making such comments, this paper argues that the classroom practices currently employed by teachers of mathematics contribute greatly towards students' learning difficulties in mathematics.

In the light of the current educational reform in PNG, this paper proposes a change in the current culture of mathematics instruction, which is fundamental to the overall success of the reform in PNG's National Education System (NES). In reflecting on the research conducted on the carpet layers and other research that examines mathematics practices in everyday situations, Masingila (1993) suggests three areas of mathematics education that require some attention. These are (a) the school mathematics curriculum, (b) the methods used in teaching school mathematics and (c) research in mathematics education. In addressing the first two areas, this paper aims to provide some suggestions for consideration under the following sub-headings.

- Re-defining the role of a teacher.
- Defining the role of ethnomathematics in mathematics education.
- Shift in teaching emphasis from procedural to conceptual understanding.
- Implications for mathematics curriculum.

Re-defining the role of a teacher

It is common knowledge in PNG that many students and parents see teachers both as an authority and the only source of all knowledge and information in the formal classroom. In many ways,

teachers themselves either consciously unconsciously encourage this view. While such a view may have advantages in other educational settings, it can become a barrier to effective learning in the formal classroom situation, in the sense that it fails to acknowledge students as equal partners of the teaching-learning process. In other words, those teachers who strongly advocate this view tend to treat students as empty mugs that need to be filled up with information that is available only within the boundaries of the formal classroom. In the actual teaching-learning situation, the teacher reinforces this view by simply not giving any opportunity for students to either ask questions or express an opinion on what is being taught. This may be a sign of teachers' insecurity, as questioning and expressing opinions may challenge their professional competence in terms of knowledge of the subject content.

Redefining the role of a teacher within the classroom context would basically require a teacher to see himself or herself as a facilitator of the teaching-learning process rather than an authority and transmitter of mathematical knowledge (Matang, 1996; 1998; 1999). In practice, this approach requires the teacher to acknowledge students as equal partners in the teaching-learning process, encouraging them to contribute meaningfully to educational activities. In other words, students are made to be active participants of an information-sharing process rather than passive recipients of information presentation. Weissglass (1992) has suggested that if mathematics is to become a vibrant and vital subject, then student/student and teacher/student interactions must be encouraged and promoted by teachers. A significant feature of a mathematics-learning environment under such an approach is that the teacher and students build the mathematics together and develop special pride in learning activities facilitated by a spirit of free and open investigation. In addition, mathematics instructional materials should be relevant to the pupil's interests and allow for student experimentation, and mathematical problems should allow students to investigate and develop a variety of problem-solving strategies, with the teacher facilitating

discussion on the validity of these strategies through reflective teaching and learning (Matang, 1998).

Defining the role of ethnomathematics in mathematics education

A number of research results (e.g. Bishop, 1991a; Masingila, 1993; Pinxten, 1994; Saxe, 1982; Zaslavsky, 1994) have shown that there are significant differences between the type of mathematics practices carried out in everyday situations within cultures and the mathematics taught in schools. Masingila (1993: 18), in particular, emphasises that mathematics "knowledge gained in our out-of-school situations often develops out of activities which: (a) occur in a familiar setting, (b) are dilemma driven, (c) are goal directed, (d) use the learner's own natural language, and (e) often occur in an apprenticeship situation allowing for observation of the skill and thinking involved in expert performance". This is in marked contrast to the way mathematics is taught in schools.

If ethnomathematics is defined both as the cultural or everyday practices of mathematics of a particular cultural group, and also a programme that looks into the generation, transmission, institutionalisation and diffusion of knowledge with emphasis on the socio-cultural environment (Bishop, 1991b; D'Ambrosio, 1990; 1991), then ethnomathematics has a role to play in the context of the teaching-learning process in the formal classroom. This is because ethnomathematics is both context-relevant and problem-specific; thus it provides the necessary linkage between the everyday cultural practices of mathematics and the teaching of the related but abstract concepts found in school mathematics (Boaler, 1993; Kaleva, 1992, Pinxten, 1994). Moreover, it also has the potential to enable students to not only make important connections between ethnomathematics and school mathematics, but also to find the relevant meaning to many abstract mathematical ideas taught in schools, at the same time legitimising the

relevance of school mathematics (Boaler, 1993; Masingila, 1993).

This approach is also in line with the rationale for one of the most fundamental principles of education, that is, teaching from the known to the unknown. As argued by Resnick (in Masingila, 1993:18), "schools place too much emphasis on the transmission of syntax (procedures) rather than on the teaching of semantics (meaning) and this discourages children from bringing their intuitions to bear on school learning tasks". Giving ethnomathematics a central role has the potential to "yield more equal opportunities provided it starts from and feeds on the cultural knowledge or cognitive background of students" (Pinxten, in Masingila, 1993: 20). Ethnomathematics complements the efforts of both the teacher and students in the learning of formal school mathematics by providing the relevant contextual meaning to many abstract mathematical ideas which otherwise would be difficult for students to learn and understand (Boaler, 1993; D'Ambrosio, 1991). What is required of the classroom teacher is to build upon the ethnomathematical knowledge that students being into the classroom from their everyday experiences, to make relevant connections between this and school mathematics, and to explain the conceptual meanings associated with the abstract school mathematical ideas. Such a teaching approach will also formalise the students' ethnomathematical knowledge gained through practical experiences in which students also develop a sense of ownership of that knowledge. An example of one such common ethnomathematical practice that is familiar to many Papua New Guinean students and can be used in teaching geometrical concepts such as properties of shapes, lines of symmetry, etc, is given below in Figure 1.

Figure 1: PNG weaving pattern
(Source: Matang 1996:67)

The pattern is part of one of the common geometrical patterns found on the woven walls of houses. While the finished product is not mathematically important, it is the planning, the structure, the imagined shape, the perceived spatial relationship between object and purpose, the abstracted form and the abstracting process that are of significance to mathematics education (Kaleva, 1992; Matang, 1996). It is one of the many familiar examples that is not only a resource for teaching a number of formal geometrical concepts in school mathematics but can also be investigated further for its higher mathematical insights commonly pursued in academic mathematics. However, in the context of mathematics instruction in schools, it makes the learning of mathematics more meaningful and relevant by providing the students with even more reasons to learn mathematics.

Shift in mathematics teaching emphasis

Based on current observations of what is happening in the actual teaching-learning situations in the mathematics classrooms in PNG, it would seem, at least to this author, that for a long time much of the teaching emphasis has been on what Hiebert and Lefevre (1986) call *procedural knowledge*. The disadvantage of this approach is that, while it promotes the development of procedures for obtaining correct answers in either arithmetical or mathematical problems, it pays little or no attention to the many important relationships that exist between different parts of the problem. Hiebert and Lefevre (1986) refer to these relationships as *conceptual knowledge*. For instance, if a group of PNG secondary school students were asked to give an answer to the fraction problem ½ x ¼, it would take them less than one minute to give the answer $^1/_8$. On the other hand, it would take a long time for the same group of students to explain the respective meanings of both the operational and conceptual relationships between the operand fractions of ½ and ¼ and the final answer of $^1/_8$. In may instances, from the

author's own experience, the students would simply give up on providing explanations to similar problems, hence forcing the teacher to do all the explanation. The situation is no different even at the secondary teacher training level, particularly at the University of Goroka in PNG. During a third year mathematics course taught by this author at the University of Goroka, students were asked either explain or illustrate both the operational and conceptual relationships between ½, ¼ and $^1/_8$ to the arithmetical problem ½ x ¼. Less than a third of the students provided responses that approached the author's expectations.and more than half provided no response.

According to Hiebert and Lefevre (1986), *conceptual knowledge* is strongly characterised by the fact that it is rich in relationships. It is a knowledge network, whereby linking relationships are as prominent as discrete pieces of information. The development of conceptual knowledge is highly dependent on the construction of the important relationships between different pieces of information. On the other hand, procedural knowledge is made up of two distinct parts – the formal language, or symbol representation system of mathematics, and the algorithms, or rules, for completing the mathematical tasks. While each knowledge type complements the other at some stage, the problem arises when students are faced with a real life problem that is different from what they learn in schools, given the fact that problems encountered in real life are never standard.

Advocating strong teaching emphasis on conceptual knowledge development is based on the observation that if one analyses the strategies used in solving everyday problems in real life, one finds that there are many different ways of solving the same problem. Making a choice of which strategy to use is basically an individual's choice. Thus, the current teaching emphasis on procedural knowledge development in mathematics does not provide the students with the flexibility to develop other problem-solving strategies that are equally important and necessary in solving problems in everyday life. Instead, the current

approach gives the students the impression that there is one and only one standard method for solving all types of problems in everyday life.

Implications for Mathematics Curriculum

In accommodating the potential role of ethnomathematics in the teaching of school mathematics, one of the first requirements for the current mathematics curriculum is that it should be flexible enough to accommodate the ethnomathematical knowledge gained from everyday practices of mathematics that students bring into the mathematics classroom. To achieve this, it is strongly suggested that mathematics curriculum should include, as Masingila (1993: 19) has pointed out, a "wide variety of rich problems that: (a) build upon the mathematical understanding students have from their everyday experiences, and (b) engage students in doing mathematics in ways that are similar to doing mathematics in out-of-school situations". In comparing the school-based knowledge with the experienced-based knowledge of carpet layers, Masingila (1993) found that some of the difficulties students faced in solving the floor covering problems were very much related to their lack of exposure to rich, constraint-filled problems. Currently, students are not encouraged to make connections between how they do mathematics in school and out-of-school situations. As a result, students do not see any relevance in the learning of school mathematics in relation to what they do and encounter outside of the boundaries of the formal mathematics classroom. Integration of ethnomathematics into the mathematics curriculum not only enables students to develop a wide variety of problem-solving strategies but also legitimises their ownership of such knowledge. This in turn adds more meaning to many abstract mathematical ideas.

Conclusion

Based on the above discussion, it is obvious that ethnomathematics has a role in the teaching of formal school mathematics in that the context-relevant and constraint-filled problem-solving strategies provide the necessary contextual meaning to many abstract mathematical concepts. In order to accommodate the role of ethnomathematics in mathematics teaching, the mathematics teachers need to see themselves as facilitators of the teaching-learning process, rather than authorities and transmitters of knowledge. This requires teachers to acknowledge students as equal partners in the teaching-learning process and active participants in the information-sharing process, rather than passive recipients of information presentation. Utilising students' rich ethnomathematical knowledge in the classroom encourages the development of a conceptual knowledge base amongst students. It also enables students to develop wide-ranging problem-solving strategies that require both teachers and students to further verify their validity in a variety of both familiar and unfamiliar situations, thereby making mathematics a meaningful and reflective subject.

References

Bishop, A.J. (1991a) Mathematics education in its cultural context. In M. Harris (ed.) *Schools Mathematics and Work* New York. Academic Press.

Bishop, A.J. (1991b*) Mathematics enculturation: A cultural perspective on mathematics education.* Dordrecht. Kluwer.

Boaler, J. (1993) The role of contexts in the mathematics classroom: Do they make mathematics more real? *For the Learning of Mathematics*. 13(2): 12-17.

D'Ambrosio, U. (1990) The history of mathematics and

ethnomathematics: How a native culture intervenes in the process of learning science. *Impact of Science on Society, 40(4): 369-378.*

D'Ambrosiio, U. (1991) Ethnomathematics and its place in the history and pedagogy of mathematics. In M. Harris (ed) *Schools, Mathematics and Work.* New York. Academic Press.

Hiebert, J. and P. Lefevre (1986) Conceptual and Procedural Knowledge in Mathematics: an Introductory Analysis. In J. Hiebert (ed.) *Conceptual and Procedural Knowledge: The case of Mathematics*. Hillsdale, NJ. Lawrence Erlbaum Associates.

Kaleva, W. (1992) Ethnomathematics and its implication for mathematics education in Papua New Guinea. In O. Ahuja, J. Renaud & R.M. Sekkapan (eds) *Quality mathematics education in developing countries.* New Delhi. UBSPD.

Masingila, J.O. (1993) Learning from mathematics practice in out-of-school situations. *For the Learning of Mathematics*, 13 (2):18-22.

Matang, R.A. (1996) Towards an Ethnomathematical Approach to Mathematics Education in Papua New Guinea: An Alternative Proposal. QUT M.Ed. dissertation, Brisbane: Queensland University of Technology.

Matang, R.A. (1998) The Role of Ethnomathematics and Reflective Learning in Mathematics Education in Papua New Guinea. *Directions: Journal of Educational Studies*, USP, 20(2): 22-29.

Matang, R.A. (1999) The Cultural Context of Mathematics Learning and Thinking of Papua New Guinea. Paper presented at the 1999 Education Conference held at the University of Goroka on 'Education for 21st Century in PNG and the South Pacific".

Pinxten, R. (1994) Ethnomathematics and its practice. *For the Learning of Mathematics*, 14 (2): 23-25.

Saxe, G.B (1982) Developing forms of arithmetical thought among the Oksapmin of Papua New Guinea. *Developmental Psychology*, 18(4): 583-594.

Weissglass, J. (1992) Changing the culture of Mathematics Instruction. *Journal of Mathematical Behavior* 11: 195-203.

Zaslavsky, C. (1994) "Africa counts" and ethnomathematics. *For the Learning of Mathematics*, 14 (2), 3-8.