Application of indigenous mathematics concepts in the elementary syllabus

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Introduction

Papua New Guinea’s *Achieving a better future – A National Plan for Education, 2005 – 2014* instructs teachers to use the local vernacular as the medium of instruction in all elementary schools. The current outcomes-based elementary curriculum has its roots in indigenous knowledge and concepts, whereby teachers can plan indigenous teaching and learning activities using resources available within their communities. The policy also allows for parents to be part of the students’ learning by helping to plan and facilitate teaching and learning activities and by providing physical and material support.

This chapter attempts to create a deeper understanding of the value of indigenous mathematics so that teachers will feel encouraged to include indigenous mathematics as part of their teaching and learning programmes. It tries to emphasise the importance of introducing the concept by highlighting experiences from PNG.
and abroad, where students who started learning indigenous mathematics before being introduced to western mathematical concepts achieved positive results.

The idea of school-based curriculum development using the outcomes derived from the syllabus is discussed. The chapter advocates, encourages and empowers teachers to use the resources available within their communities in their mathematics teaching. It is hoped that this strategy will help students to value and appreciate their indigenous mathematics and improve their performance as they continue their lifelong learning.

**Indigenous mathematics**

Indigenous mathematics is the traditional form of mathematics that belongs naturally to the people. In some countries, indigenous mathematics is taught in schools. The impact of this is as yet unclear because the level of implementation is low compared to western mathematics, which is still favoured over indigenous concepts (Lipka & Adams, 2004; Morris, 1980; Owens, 2001). Many other countries pay lip service to planning and teaching indigenous mathematics lessons and unfortunately Papua New Guinea (PNG) was no exception. However, the establishment of elementary schools throughout the country and the use of vernacular languages as the medium of instruction at this level have laid a strong foundation for introducing indigenous mathematics into the school system.

In PNG, where students often speak English as a second, third or fourth language and are under-performing in mathematics, the idea of introducing indigenous mathematics using their vernacular as the medium of instruction is a step in the right direction. This is especially important at elementary level, when children begin formal education, so that they can be guided in their exploration of mathematics, indigenous and western. This will also engender in students a pride in and ownership of the subject as they relate their learning to real life and practical situations. This complements *A National Plan for Education, 2005 – 2014* that emphasises the importance of students’ previous experience and local knowledge in the vernacular:
At 6 years of age all children begin their education in a language they speak and for the next three years they develop the basis for sound literacy and numeracy skills, family and community values including discipline, personal health care and respect for others (PNG-DOE, 2004:15).

Mathematics occupies a conspicuous place in the curricula of schools in many countries. ‘Some have included mathematics as a matter of course; others have sought philosophical, psychological, pedagogical and many other justifications for doing so.’ (Morris, 1980:106). PNG has chosen mathematics in order: “to have a mathematically literate population who will participate in the development of the nation.” (PNG-DOE, 1986: 24).

International research

The indigenous mathematics concept has a major role to play in terms of student learning and it must be critically considered by all the stakeholders including policy-makers, curriculum developers, implementers and the community at large (Matang, 2005; Muke, 2005). Countries such as Australia, the United States, India, Tanzania and others have trialled the concept with their indigenous communities and found the idea to be an effective method of linking to western mathematics concepts.

In Australia much has been done about indigenous Aboriginal mathematics, resulting in strong policies such as the Torres Strait Islanders’ education policy. An important step forward was also made with the New South Wales Board of Studies project: the Mathematics in Indigenous Contexts project (2003-2005), which was undertaken in a rural NSW site. It demonstrated how shared ownership of mathematics curriculum development among Aboriginal and non-Aboriginal community members could enhance the understanding and respect of each group for the other as well as develop the mathematical knowledge of students in the community.

Further studies on the topic were carried out by Lipka and Adams of the University of Alaska, Fairbanks. The studies indicated that culturally based mathematics can improve Alaskans’ native students’ mathematics performance (Lipka & Adams, 2004).
Background and significance of indigenous mathematical concepts in Papua New Guinea

Papua New Guinea is a diverse country with more than 800 languages and counting systems (Bray, 1984: 19). The first schools were built by the colonial powers, where mainly literacy and mathematics were taught to the ‘natives’. Education during that period was greatly influenced by the early explorers, traders and missionaries, and the type of mathematics taught in these schools was mastering simple facts in order that the learners could do simple chores like adding, subtracting and measuring. Long before western concepts were introduced, however, PNG’s indigenous mathematics had been part of tradition. The people were able to count, using body parts, sign language, groupings and bundles, and they were able to measure, estimate, make logical guesses and predict time. All these were part of their daily life and survival (Bray, 1984; PNG-DOE, 1986; McLaughlin, 1991).

Indigenous mathematics concepts can play an important role in facilitating student learning. Anecdotal evidence suggests that students who possess a good grasp of indigenous mathematics concepts can perform better when applying western mathematics in solving practical real life problems, and studies have proved that students do better in mathematics having learnt indigenous mathematics in the early years of schooling (Lean, 1991; Lipka and Adams, 2004; Matang, 2005; Muke, 2005; Owens, 2001).

In PNG, studies undertaken by Brith, Kada, Lancy, Malaga, Roberts and Souviney (Souviney, 1980) on the indigenous mathematics in different parts of the country led to a five-year Indigenous Mathematics Project being established by the government to investigate various aspects of traditional mathematics development. During the first phase of the five-year project (1977-1978), basic indigenous counting, classification and measurement systems used throughout the country were documented. During the second phase of the project, pilot instructional mathematics materials were developed and trialled in selected schools. The main purpose, according to Souviney (1980), was to assess the feasibility of utilising contemporary aspects of indigenous and western mathematics as a basis for developing culturally relevant student materials, instructional aids and teacher
guides. The results of this project were intended to inform curriculum development in an effort to provide more appropriate instructional materials and learning aids for community schools throughout PNG. It was also intended to look at potential ways of changing the classroom environment to enhance students’ mathematical achievements.

The elementary cultural mathematics syllabus

Studies have called for educational programmes to connect the culture of the community to the culture of the school, including the use of local language, local knowledge, and local involvement (Lipka & Adams, 2004). If this is not done, there may be a mismatch between what the students learn in schools and the understanding of the concepts at home. Students bring from their homes experiences and a wide indigenous knowledge (Lipka & Adams, 2004) and there is a real need for teachers to build on this (Matang, 2005; Muke, 2005). Many term this as teaching from the known to the unknown. Lancy (1978: 14) states:

> What children learn in Primary schools follows on from what they learn in Elementary schools. In Elementary schools, children learn to read and write and discuss things in their own language. They are usually doing things that are part of their own community.

Under the current curriculum reform, the Papua New Guinea Department of Education (PNG-DOE) published the elementary cultural mathematics syllabus and elementary teacher guide in 2003. These are now used throughout the country. The syllabus has three learning principles, and the following description shows how these principles underpin it. They are:

- we learn best when we build new learning on what is already known,
- we learn well when we recognise an immediate need for what is to be learned, and
- we use ideas in a coordinated way to solve real life problems. (PNG-DOE, 2003: 3)

The syllabus emphasises the importance of teaching new knowledge and concepts in mathematics, based on what the students already know. It is argued that this will
result in students doing well (Matang, 2005; Muke, 2005). Therefore, the syllabus has its roots deeply embedded in cultural knowledge and is an excellent avenue to introduce indigenous mathematics teaching and learning activities to children at the elementary level. Furthermore, the language of instruction is the students’ vernacular and as their teachers come from within the community, they are able to explain the mathematical concepts clearly to the children in a language they understand. At Grade 3 the percentage of language use stands at 60% vernacular and 40% English, while at Grade 4 it is 50% vernacular and 50% English, and 30% vernacular and 70% English at Grade 5. The percentage calculation does not exist at the upper primary level, but it is anticipated that vernacular languages will still be used to reinforce teaching and learning and facilitate student understanding (Matang, 2005; Muke, 2005). What this means is that the vernacular plays an important role in teaching and learning at all levels.

Consistent with the Department’s language policy (Ministerial Policy Statement, 1991), the use of vernacular languages will facilitate student learning and assist students who seem to lag behind in learning. This is also consistent with the aims of the outcomes-based education, which considers individual students’ learning needs and abilities and allows students to learn at their own pace to achieve targeted end results or stand points (PNG-DOE, 2004, 2003).

Students will be able to link new mathematical concepts to their existing cultural knowledge, as the elementary cultural maths syllabus encourages teachers to set mathematics in contexts that are familiar and of interest to the students. For example, when there is a talk of a feast in the community, teaching activities could revolve around the event, how the elders will prepare the feast, who and how many will be involved, how much food will be cooked, how the food will be shared and so on. Students will value the learning more if they recognise an immediate application of what they are learning, and they will integrate this knowledge so that they can confidently use mathematics in their everyday lives.

Teachers are able to teach and students are able to learn when the outcomes of the learning are explicit and are shared. The elementary cultural maths syllabus is outcomes-based and its teaching and learning programmes are prepared using
clearly stated outcomes that can be achieved or demonstrated at a particular grade in a particular subject. The outcomes are student-centred and written in terms that enable them to be demonstrated, assessed or measured (PNG-DOE, 2003). They are accompanied by a list of indicators that identify the knowledge, skills, attitudes and values that students will need to demonstrate in order to achieve these outcomes.

The content of the elementary cultural maths syllabus is organised into five strands: space, measurement, number, patterns and chance. The strands are further organised into a number of sub-strands to allow the content to be specific and described as a learning outcome. These outcomes are manageable and show a clear progression from one grade to the next (see Table 1 on the next page for an example.) At the elementary level, most of the outcomes for mathematics are closely related to the students’ culture and communities, thereby assisting the teachers to plan and programme indigenous mathematics teaching and learning activities.

Since the language of instruction at this level is the learners’ own language, teachers can engage parents to assist in the actual planning and teaching of indigenous mathematics lessons. This will engender a feeling of ownership for the parents. At the same time it will greatly assist the students as they relate their indigenous mathematics concepts to the western concepts and vice versa (PNG-DOE, 2003; Matang, 2005; Muke, 2005).

Table 1 Outcomes of the space strand for the three elementary levels

<table>
<thead>
<tr>
<th>Strand</th>
<th>Elementary Prep</th>
<th>Elementary 1</th>
<th>Elementary 2</th>
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<tbody>
<tr>
<td>Space</td>
<td>P.1.1 Follow and give simple directions for moving in a space P.1.2 Identify locally known shapes by their visual appearance</td>
<td>1.1.1 Follow and give directions to move from place to place 1.1.2 Compare and group shapes in the community</td>
<td>2.1.1 Follow directions from simple maps 2.1.2 Investigate and describe the features of geometric shapes</td>
</tr>
</tbody>
</table>

Source: PNG-DOE, 2003: 9-10
School-based curriculum development

Strategies used to create sample units of work by the teachers of Crawford and Walhallow public schools in New South Wales, Australia for their native Aboriginal students can be utilised at the primary schools in PNG. Teachers can plan teaching and learning activities from the five mathematical strands (number, space, measurement, chance and patterns), using the outcomes that address indigenous mathematical concepts and creating units of work that can be taught over a certain period of time. For example, outcome 4.2.1: *Estimate and measure lengths, distances and perimeters using standard units of length*, could be addressed by creating a unit ‘Building a house’. Students could be taken to a location where people are building houses using traditional materials and methods. Discussion, in the vernacular, can focus on the types of materials and measurement strategies that are used. Students can relate the indigenous measurements used for the house to the metric units of measurement when they return to the classroom.

Developing indigenous mathematics teaching and learning activities will not create new outcomes—the reality is that the existing outcomes from the elementary cultural mathematics syllabus that address indigenous mathematics will be clustered, and teaching and learning activities or units will be developed based on these outcomes.

The idea of producing indigenous mathematics units of work will promote the government’s plan to have all districts produce their own local curriculum materials by 2012. As stipulated in the national plan for education (PNG-DOE, 2004: 47):

> The department of education will support the provinces and districts, in terms of both technical assistance and financing, with the development of locally-based curriculum materials. They may include the establishment of district curriculum committees.

The concept also supports the relevant recommendations from the national skills plan, *Enhancing their Futures: skills education in Papua New Guinea, locating and understanding the issues*, (PNG-DOE, 2000). It will also re-emphasise the PNG Government’s stated policy and as such will work for the country as it will be
supported by the government in terms of technical assistance and finance (PNG-DOE, 2004).

**Conclusion**

Bringing about change is not an easy task; it requires the dedication, commitment and ownership of those who want to be innovators (Proudford, 2003). Many innovators and implementers hold the view that constant change poses significant constraints on people when they are already faced with many changes and the workload that comes with those changes. However, there should be a willingness to make changes in the roles of assessment and the mode of curriculum delivery—from being a transmitter of information to a facilitator of learning.

As Proudford (2003) states: ‘Changes of such magnitude and complexity transform teachers’ work because they represent ‘a shift from one set of assumptions, beliefs, norms, behaviours and practices to another’ which in turn create a new culture of learning and teaching. In essence, the changes call for a ‘fundamental reculturing of schools’.

**References**


