

Policy and Practices: Indigenous Voices in Education

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Abstract

This paper presents some policies and practices that occur in Papua New Guinea and Australia. It is argued that school systems must recognise cultural mathematics and teachers need to establish dialogue with communities, especially Elders, in order to provide a socially just education for Indigenous students. Several recent policy recommendations are provided as examples but there is still much more to be done to provide adequately for Indigenous mathematics education. One aspect needing development is the making of links between culture and school mathematics in order to maintain and develop a richer mathematics. Several examples are provided.

Introduction

Papua New Guinea and Australia have quite different colonial history with Indigenous cultures being dominant in PNG whereas Indigenous cultures in Australia have suffered from invasion, and attempts at annihilation and assimilation. Nevertheless, both countries have policies to establish recognition of Indigenous cultures. This paper discusses the policies and their implementation in practice. In particular, it considers what this means for mathematics education since school mathematics is often perceived as that introduced from western Europe.

An overview of the mathematics of many of the cultures of Papua New Guinea can be found in Owens (in this issue). The complexity and richness of Indigenous mathematical knowledges are well established in this article and by many other authors, too many to name here. One paper on mathematics in Indigenous Australia but also in other countries is found

¹ The importance of ethnomathematics in policy and practice was a driving force for Rex Matang. This paper is dedicated to Rex who was a chief Elder for his Kâte community Papua New Guinea, researcher, teacher, and advocate for ethnomathematics in PNG. He held positions on most national advisory boards on mathematics in schools.

in Owens et al. (Owens et al., 2011). This paper sets mathematics education in an eco-cultural, critical, place-based framework. In other words, it establishes how mathematics education in schools can build on culture and place (Gruenewald & Smith, 2008).

The first purpose for valuing Indigenous knowledges is to encourage school systems to build authentically on Indigenous students' home and community knowledge and to accept a recognitive view of social justice by adapting Indigenous knowledge in schooling systems (Apple, 2004). The second is to influence educators understanding of how students may learn mathematics and indeed to extend both pedagogical practices and mathematical content and processes. This paper outlines and evaluates government attempts to do this in Papua New Guinea and Australia.

Recent Policies Encouraging Recognition of Indigenous Knowledges – Australia

There have been recent policy changes in Australia that encourage genuine partnerships with Indigenous communities. National funding requires genuine partnerships for projects to improve Quality Teaching and Learning specifically for Indigenous education. As a direct response to the review of Aboriginal Education (Laughlin & Ella, 2004), there was a new NSW² Aboriginal Education and Training Strategy 2006-2008 (New South Wales Department of Education and New South Wales Department of Education and Training, 2005 [NSWDET]) with a further revision in (Aboriginal Education and Training Directorate, 2005; New South Wales Department of Education and Training, 2008). It incorporated an approach to improving Indigenous education by establishing recommendations for systemic change. This was similar to that of the Federal government's policy which recommended systemic change based on a number of pilot studies (Ministerial Council on Education Employment Training and Youth Affairs, 2005). The first goal of the National Aboriginal and Torres Strait

² New South Wales (NSW) is a State of Australia. States are responsible for education funded by Federal and state taxes but Federal governments provide project funding and more directives tied to funding, curriculum and assessment.

Islander Education Policy is “to establish effective arrangements for the participation of Aboriginal and Torres Strait Islander parents and community members in decisions regarding the planning, delivery and evaluation of pre-school, primary and secondary education services for their children” (Department of Education Employment Work Relations, 2009).

Previously Indigenous education projects were not part of mainstream thinking (Moroney & Brinkworth, 2003). Furthermore, empowerment may not have occurred at the local community level especially when the project guidelines were generalising the diversity of Indigenous cultural identities. While mobility, attendance and retention had to be addressed, an additional theme, applying Aboriginal cultural knowledge, became part of the (2008) NSWDET review. MYCEETYA (2005) recommended provision of culturally appropriate preschools, strong school and community partnerships that include emphasis on the value of schooling, high educational standards and Indigenous leadership. This should result in student identity that also incorporates these values. It was also noted that quality teaching included knowledge for solving problems, engagement, social support and student self-regulation. Mentoring students in school and beyond in the workforce is recommended by Aboriginal Hostels³ in NSW. Several reports (e.g., Moroney & Brinkworth, 2003; New South Wales Department of Education and Training, 2005, 2008) noted that there was a lack of knowledge and a lack of ways of knowing what Indigenous students know and can do. There was a need for investing in community engagement, partnerships, and knowledge of available community personnel.

One particularly important recent project has been undertaken by the Australian Association of Mathematics Teachers. This project involves clusters of schools that represent quite diverse contexts from remote areas, to large country towns, to city schools in many States and Territories (Australian Association of Mathematics Teachers, 2009). In addition,

³ These provide accommodation and support for students leaving home to continue their education. More emphasis is placed on supporting students over time and when they move into the workforce.

another project in Western NSW sets out a range of general principles related specifically to curriculum (Yunkaporta & McGinty, 2009).

Partnerships have been the key in a number of recommendations and practices such as Family-School Partnership projects (Department of Education Employment and Workplace Relations, 2008) and Communities for Children (Slack-Smith, 2008). For partnerships, successful community engagement must develop and the following principles and processes have been found to contribute to this engagement. Open, trusting, authentic relationships are needed at the personal and institutional level and take time and sharing to develop. The community engagement must be planned and supported by structures, including communication and mentoring processes, that will sustain it. This includes establishing appropriate agencies that recognise and maintain Indigenous relationships. The goals must be articulated and benefit all, articulating inequalities and injustices, exploring and implementing solutions. Awareness must be raised of these injustices and willingness to engage in and address these issues (Gervasoni, 2005).

The Western NSW project emphasized the importance of “building learning around deep understandings of Aboriginal pedagogy, designing learning through intercultural collaboration, and allowing quality cultural content to emerge through Aboriginal pedagogy and intercultural collaboration” (Yunkaporta, 2009, p. 37). From this, metalanguage would be cultural metalanguage which would be different to mainstream language. For example, logic would be more than linear logic, it would involve whole picture perspectives, making connections between knowledge from different sources, taking time for reflection and re-presentation.

However, for these characteristics to develop, cultural understandings and decolonising of the curriculum and teachers’ approaches must develop. The history and culture of Indigenous communities and their languages should be taught in school.

Relationships would be enhanced by the use of culturally appropriate ways in schools. An increase in the employment of Indigenous staff members would permit other teachers to observe ways that are appropriate for the community and simultaneously reduce staff turnover (Hockey, 2008).

There is much still to be learned by educators about community partnerships. From an extended discussion (yarn up) with community and Indigenous people and colleagues from three other countries, a framework was developed that viewed the child standing on the foundations laid by the contexts of the child (Figure 1): the child in house and family, the community, the school and the social environment. Key to learning is the place of Elders in these contexts and the roles they play. The discussion also considered how best to view the knowledges that could be shared and how best to incorporate that as place-based, outdoor education and learning established by partnerships with Elders who have a genuine say in what is happening. This was suggested to be true democracy where Indigenous rights and respect for Indigenous people meant meaningful, engaging and self-determined education (Owens, et al., 2011).

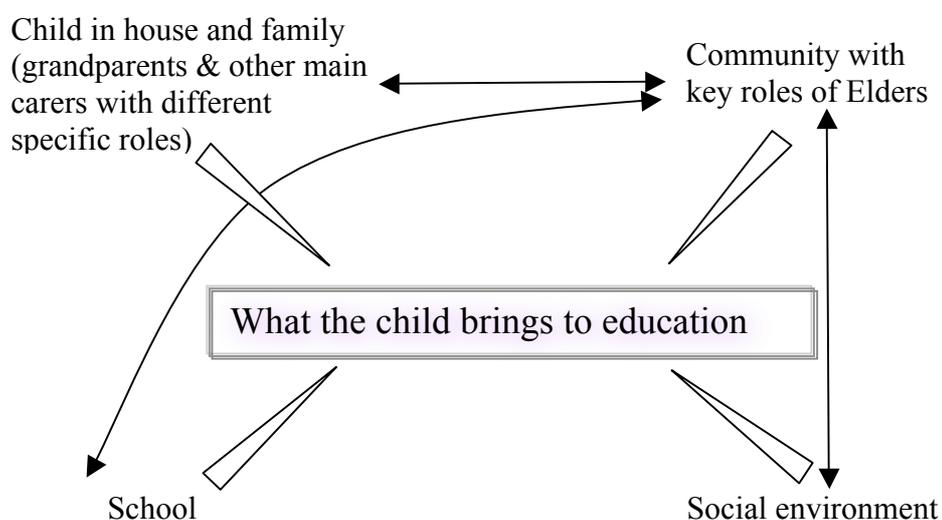


Figure 1. Elders role in the education of the Indigenous child.

In order to really appreciate this framework and to establish strong partnerships, we need to see how the policies revolving around partnerships have been implemented. One of these is the Smarter Stronger Leadership Training (Smarter Stronger Indigenous Education Leadership Institute). An example of a case study which illustrates the effectiveness of this process can be found in Owens (2011). Typically teachers, other staff, and community leaders are challenged in terms of their own attitudes and beliefs towards Indigenous students and education. There are two block residentials and on-going planning in their schools or institutions throughout the year. They learn the importance of the past and culture which provide the roots for developing a fruitful tree in the future. They plan to develop relationships with the community and to transform practices with small steps. With a support network and more teachers participating in the year-long training program, teachers report changes in their attitudes, their relationships with community and families, their programs, their expectations of students, and students' attendance, participation and improvement in class work and on national tests.

Recent Policies Encouraging Recognition of Indigenous Knowledges – Papua New Guinea

In the mid 1990s, Papua New Guinea (PNG), with advise from the World Bank, decided to restructure its schooling so that more students had access to education especially in rural areas, that more students could reach Grade 8 at school, and that more students could participate in schooling up to Grade 12. Hence elementary schools were to be set up, children being able to start school at a younger age and in their village or nearby. Villagers were to build these schools and recommend teachers who then received minimal training together with training in the schools from more experienced teachers. These schools covered pre-

elementary, elementary Grade 1, elementary Grade 2. Primary schools were to cover Grade 3-8, two years more than previously with subjects in Grades 7 and 8 being previously in high schools and often requiring teachers specialising in humanitarian or science strands. High schools then were to go from Grade 9 to 12 whereas previously they had been Grades 7-10. However, some villages continued without elementary schools and primary schools sometimes covering Grades 1 to 6 or to 8. The four senior National High Schools were to remain (Grades 11 and 12), provincial high schools as well as city or regional high schools were to be established. There were still a number of tests that had to be hurdled to move on to Grades 9 and 11.

In addition, the Reform was to implement education that promoted the cultures of PNG and equality for women. Cultural knowledge was to be part of all years of education but there was particular emphasis in elementary schools. Children were to learn initially in their home language as far as possible with a transition to English during Grade 3. There was considerable Australian aid to build capacity, mainly human, for the development of this Reform including the Primary and Secondary Teacher Education Project (PASTEP), and Curriculum Reform Implementation Project (CRIP) which included elementary schools. Project consultants had PNGian counterparts and there were several short curriculum development stages. The evaluation of the elementary school project suggested that most teachers had at least Grade 10 education and some inservice courses (usually 2 weeks residential plus distance materials), received and appreciated the curriculum support materials but were not necessarily as creative in harnessing the community knowledge as they might be. Trainers in helping them with planning and programming may have inadvertently discouraged this. However, most teachers preferred to teach in the vernacular in villages and Tok Pisin in towns and they found the curriculum materials very helpful (Evans et al., 2006).

The evaluation of the PASTEP project found that there was significant improvement in the quality of teaching and curriculum in primary teachers colleges. They also found some references to culture in the mathematics curriculum subjects but in most cases ethnomathematics was an elective subject with small sections in the core subjects and some assessment tasks specifically linked to cultural knowledge (Clarkson, Hamadi, Kaleva, Owens, & Toomey, 2003).

From Cultural Studies to Education

There are two aspects to moving forward. The first relates to the curriculum while the second relates to pedagogy. A literature review on Aboriginal children's numeracy (Frigo, 1999) noted teaching strategies should support parents and communities in being involved in their children's learning. She went on to say the content should:

- value Aboriginal students' diverse cultural and linguistic heritages;
- make explicit the difference between western mathematics and Aboriginal mathematics, and value both equally ;
- make explicit the link between community, home and school mathematics;
- provide realistic and real-life classroom contexts for mathematics activities;
- be developed in consultation with local communities and Aboriginal education workers; and
- be open to and encourage modifications of content and pedagogy to reflect particular students' interests and learning needs. (Frigo, 1999)

Frigo made similar comments about materials and resources used by Indigenous students.

In the Northern Territory, the Yolgnu people through the Garma Project have begun with their own mathematical systems in formal education and then introduced western mathematical systems. Where position of land is expressed in Yolgnu in its complex relationship with people, it may be used to introduce position grids in school mathematics. The recursive nature of relationship patterns are also valued mathematically (Thornton & Watson-Verran, 1996). Bilingual education is part of this educational approach. However, changes in education policy have emphasised teaching in English and strategies for teaching

students with linguistic and cultural backgrounds that differ from the mainstream. Such approaches would seem to reduce Indigenous voice (Dawson, 2005; Owens, 2010).

The Reform agenda in Papua New Guinea (Dawson, 2005; Kaleva, 2009; Litteral, 2001; Matang, 2003) also emphasises culture. Elementary schools based in the community have a syllabus called Cultural Mathematics. Children should be taught in their home language using counting systems and other words relevant to numeracy. Teachers have been provided with resource books such as Elementary Patterns Resource Book: Good Beginnings in Mathematics with Patterns (Department of Education PNG, 2006). Teachers are encouraged to use play and games, local and school provided objects like linking blocks for students to make patterns to learn about patterns. They are encouraged to use visual, aural and vocal, and movement and rhythm patterns. They are encouraged to use local examples of patterns in spatial arrangements, shapes, time markers, and counting systems. Repetition and relationships (or linking rule) are emphasised. The book includes the following quotation which shows not only how diverse the country is but that teachers are encouraged to find their local patterns and use them for teaching.

In different communities fish, bananas, firewood and sago are counted in different ways. For example the people of Aroma who speak the Kaekalo language use a base ten system for counting but bananas, yams, taro and fences are counted with different bases. Similarly the Yolkom people of Kiunga Lake Murray District use base ten with bananas and sugar cane being counted differently. The people of Oro Province who use the Ewa Ge language, also use base ten, the exception being the counting of taro, betel-nut, and bananas. The Kiwai people of Western Province and the Daga people of Milne Bay Province use base five whereas the Kuman people in the Simbu Province count in twos. For the Misima people, different counting systems may depend on the activity such as gardening, fishing, feasting and Kula trading. Sago and coconut are tied in bundles of four and counted and yams are counted in base two. The people of Namatanai in New Ireland Province mostly use base five for certain cultural activities such as bride price, pig pricing, sewing sago leaves for housing, and counting traditional shell money but for feasting and sharing of food a base four system is used. The western number system which is also used in Papua New Guinea is a pattern which groups numbers into tens, tens of tens, tens of tens of tens and so on. This numbering system (is used for many purposes but)... measurement of time

uses different patterns.

Teachers are also given advice on what questions to ask, how to involve the community, and how to link with mathematical strands and other subjects. They are given a number of exemplar lessons with appropriate questions, extensions, and encouragement to predict. Then they bring in ways of recording the patterns.

However, changing times makes it hard for these initiatives to be implemented. One issue is around students operating in the dominant culture. In PNG, the common view is that people are leaving their old complex languages behind and adopting hybridisation of Tok Pisin and local language. The reverse is noted in NSW where colonisation forbid the use of vernacular languages. People are reviving their language, redeveloping identity, and decolonising education as best they can. This will be much harder with a National Curriculum associated with national testing. The draft curriculum gives lip service to culture but it does not incorporate it into the relatively atomised western mathematics outcomes.

It was Matang's concern that there should be research to see how using vernacular, or Tok Pisin or both, with English, would impact on children's learning. His studies indicated the use of vernacular languages without Tok Pisin and with a bridge to English strengthened children's arithmetic skills in their home language and in English more than the use of Tok Pisin (nearly finished doctoral thesis before his death). His study used a questionnaire that was based on the Schedule for Early Numeracy Assessment from NSW *Count Me In Too* project (NSW Department of Education and Training). It was presented in the vernacular (several of which he spoke in different areas of the country where he had been a teacher) or Tok Pisin. Children answered in the language they selected to use. Paraide (2003) had also found students did well in early arithmetic strategies if taught in elementary schools in the home language in a range of locations.

These PNG studies support the claim that learning based on cultural knowledge strengthens mathematical understanding. A similar result was also found among the Yu'pik in Alaska (Lipka & Adams, 2004) and is currently investigated by Jannok Nutti with Sámi children of Sweden (Jannok Nutti, 2008). Among the competencies for teachers, is that of cultural competence.

Cultural and School Mathematics Learning

When we look at the processes of education and the theoretical underpinnings for the educational process, there is much to be learnt from studying different cultures. In the first place, there may be ideas about the concepts that are foundational to our understandings but need to be made more explicit for early childhood education (Ness & Farenga, 2007). Furthermore, there may be a reversal of the construction of concepts from that commonly held in western developmental psychology which states that the child constructs relative (projective) spatial concepts, that is those in relationship to his or her own body (in front, behind, left, right) before developing absolute (geocentric) concepts. In a small study in Bali, Indonesia (Wassmann & Dasen, 1994), found indications that, in some cultural (and linguistic) contexts, this sequence could be reversed. Using two tasks, they found that young children in Bali used a completely absolute (geocentric) encoding of spatial arrays; older children and adults, while also showing a preference for the absolute encoding system (coherent with the culturally sanctioned orientation system), were also able to use a relative encoding. This discussion suggests a reversal in stages of cognitive development that dominates current early educational theory, and an argument in favour of (moderate) linguistic relativity. Harris (1989) also noted that small children responded to north-south, east-west descriptions in remote Australian Indigenous groups. Spencer and Darvizeh (1983) compared the route descriptions of British and Iranian preschool children. The latter group

gave more vivid and fuller accounts of sites along a route, but less directional information than the former. By three years of age, children were found to communicate spatial information to others in the manner of adults in their culture, suggesting that communicative competence in the spatial domain involves the acquisition of culturally patterned skills for describing space.

Furthermore, cultural artefacts may facilitate individual's spatial thinking. For example, people may use maps or diagrams and even preschool children can acquire a sense of large scale space from maps. This visuospatial knowledge may be restricted to certain cultural groups as found with Australian Aboriginal maps (Harris, 1989; Klich, 1988) (Harris, 1989; Klich, 1988) or Puluwat (Micronesia) navigation maps (Hutchins, 1983) or route descriptions in Yupno, PNG, (Wassmann, 1997). In Micronesia, children learn the star positions on a star compass of 32 points. Stones are used to learn the main positions first and gradually the various games become more complex. One game, island hopping requires the names of islands on a particular star direction. Routes are combined and reversed in the games which have various nautical names. Dragging is a game in which the children give the position of places from a place which is not their home (Penn Museum, 1997).

Explicit Content Links between Community, Home and School Mathematics

Owens (2000) has shown how the Indigenous numeracy systems of PNG can be utilised to teach arithmetic strategies in English. For example, one of the common counting approaches is by hand (five), two hands (two fives), two hands and a foot, man (two hands and two feet). This digit tally or (5, 20) cycle system permits groups of 5, and an easy way of representing and skip counting by 5s. This system is well known across the world among Indigenous communities such as the Yu'pik in Alaska and the Wiradjuri in Australia. Further details on counting systems are given in Owens, this issue. In a study in one village

elementary school near Goroka, PNG, the NSW Count Me In Too activities were adapted to games in the vernacular (one of the versions of Gahuku-Asaro or Alekano). The counting words were based on 1, 2, 2+1, 2+2, 5, 5+1, 5+2, 5+2+1, 5+2+2, 5+5, 5+5+1 etc as this was a (2, 5) cycle system with 20 implied for Asaro⁴. Some of the words for a number like 8 or 14 were long. However, the use of morphemes to make up the counting words assisted students to order the counting words and to represent them with stones. We counted together using hand gestures, bending fingers as we counted to 10. Then we counted using my hands and “borrowing” the teacher’s hands to count to 20. We counted around the circle orally with each child saying the next number, albeit helped by the teacher or other children. We counted around the circle with every second number louder so that the even numbers were more obvious. We gave children the vernacular words and asked them to line up in order, first to 5, then to 10 and eventually to 15. We then counted in twos, that is 2, 4, 6 etc. We also tried group or skip counting in 3s which the children found less easy but it was easily achieved by the teacher. In small groups, we matched vernacular counting words with stones. We also matched dot cards with vernacular words and English words and numerals. Faster groups moved onto numbers beyond 10. The groups also tried some simple addition of numbers up to 10. This was matched with stones being added together. The group work was essential as there was a wide range of literacy skills in the vernacular and English among the children and a number of children spoke Tok Pisin and/or another language at home as there were several

⁴ Lean summarised the variety of Gahuku-Asaro counting words. We had to modify our prepared cards when we arrived to match this particular village Gavehumito version. I have recorded several other different versions within this language group. 1 hamo; 2 losi; 3 losive makole; 4 losive losive; 5 ligizani luga
 6 ligizani luga ham; 7 ligizani luga losi; 8 ligizani luga losive makole; 9 ligizani luga losive losive; 10 ligizani luga luga or asasi hamo
 11 asasigi hamoki; 12 asasigi losigi; 13 asasigi losi hamo; 14 asasigi losive losive; 15 asasigi ligizani luga
 16 asasigi ligizani luga hamo; 17 asasigi ligizani luga losi; 18 asasigi ligizani luga losive makole; 19 asasigi ligizani luga losive losive; 20 asasi losi
 21 asasi losi hamo; 100 asasi ligizani luga luga (stick); 200 go' hamo (bilum bag); 1000 mulisi (hip = heap)

families of marriages from more than one language group. However, all the children would have regularly heard the vernacular and Tok Pisin spoken in the village.

The strength of the current elementary teacher education system has been on training teachers with approaches to teaching and to making the adaptations needed for their communities. They need to be resourceful. PNG government has found, at great expense, that loans to produce pupil books with teachers' guides may not have been as profitable when books merely contain pictures with instructions to use the vernacular language. Over time, the school is often left with a few pupils' books and no teacher's guide.

Appropriate Pedagogy

The second important area of teaching relates to the way mathematics is taught in schools. Some general approaches and policies have been discussed above but these can be further developed at the school level. "Learning pathways are not direct and the outcomes and the journey are one and the same. This logic can be seen in the language" (Yunkaporta & McGinty, 2009, p. 62). Learner autonomy is a valued Indigenous pedagogy but it requires a fine balance between self-direction and social support. It can be hard to re-establish it in a classroom that has followed more authoritarian approaches in the past as students revert to misbehaviour. Nevertheless making the connection with communal knowledge protocol and expecting intellectual rigour can restore productive learning (Yunkaporta & McGinty, 2009).

Another key for Indigenous students is to use stories. For example, in Yunkaporta and McGinty's study they established the communal knowledge protocol by using the importance of three rivers joining as a way of learning together and thinking laterally, and they used a procedural story of the community's past activity to introduce students to writing their own procedural stories. In this case, knowledge came not only from teachers but also from land and ancestors.

The deficit model of social justice (Apple, 2004) leads to accepting that high expectations are what is set in the syllabus and in English. This deficit model and emphasis on western mathematics can be well ingrained in teachers, and requires some unpacking for them to realise that high expectations is in the values of the Indigenous community rather than the syllabus outcomes. While it is an acceptable Indigenous practice that knowledge might be shared over time, Yunkaporta (2009) notes that sophisticated awareness of one's own identity and engagement in local knowledge protocols is needed to come to Indigenous knowledge with integrity.

The Western NSW Region project suggested that the following eight ways would be used:

- Tell your stories about the topic or related topics;
- Get students to tell theirs and discuss that knowledge in depth;
- Show a model of the work students will produce for this topic;
- Ask how this helps/relates to local community?
- Pull the model apart, question the meaning;
- Map out the structures, explain the patterns and codes;
- Work with these visually and kinaesthetically;
- Support students to recreate their own versions individually;
- Ensure these understandings are returned to community for local benefit. (pp. 22-23)

Cherinda's (2002) work in Mozambique on weaving is a good example of this approach. Linguists working in PNG preparing materials for elementary schools have also worked in this way to the extent that they have facilitated (assisted in unpacking language and mathematical structures) the teachers (from the community) to select their ways of teaching and materials for teaching (Litteral, 2001).

Similar examples can be found with the University of Goroka, PNG, teacher education student projects. At first glance these seem to be like the familiar mathematics

trails where built environments and cultural activities become key initiating or engaging activities for the work of the syllabus (Owens, Pattison, & Lewis, 2003; Vincent, 2007). However, the cultural connections are in fact stronger. There is a sense of pride in their cultural pursuits and the socio-cultural context is well established as suggested by Owens et al. (Figure 1). There is a connection between their cultural roots and mathematics (Owens, 1999). The underlying concepts are more closely linked to their place-based experiences and so they take on a well-rooted meaning.

All Papua New Guinea students should not overlook the potential of their forefathers which are embedded in the traditional /cultural activities in their respective cultures. Our forefathers should not be regarded as primitives around the place. It is a very tough challenge to this generation that they should look deeper into some important mathematical ideas and skills that were involved in the activities that were done by our forefathers. ... These ideas include the design of very peculiar bridges, (Siegel, 1982), all over the country (PNG). Not only mathematical ideas were involved but also some social and scientific knowledge. For instance, gathering of people for the ground breaking ceremony, is social knowledge, and the idea of collecting very rigid material to withstand the pressure due to loads carried by the people who cross the bridge and the consideration of the resistance of the materials to decay is scientific knowledge. Siegel (1982) strongly stated that PNG forefathers were very good in applying highest mathematical and scientific knowledge unconsciously in traditional engineering designs of bridge construction. (Yuofoho, 2005)

She provides secondary school exercises that related to the shapes and sizes associated with this bridge (see Owens on PNG knowledges this issue for a picture and words related to the bridge). A picture and description of a bridge at Kagua by Yambi is also given in Owens this issue, but in the current paper we look at his values about his people's mathematics and some of the exercises he presented in relation to this bridge building.

Attempts to link school mathematics with the traditional activity and artefacts sometimes resulted in approximations to either the traditional practice or the mathematical concept. This can be seen in the following quote linking the vines on the bridge with the naming of curves in school mathematics and in the diagrams of Figure 2. Nevertheless, the

idea of distances and the appropriate use of triangular geometry provides a familiar cultural context, although this would not have been traditionally calculated. The mental imagery of previous bridges is the mathematical source for the actual bridge making and the experiences of ratio in practice.

The Kewabi dialect speakers of the eastern part of Southern Highlands Province, PNG, have some of their major traditional practices; materials, activities, events and phenomena ... which involved some form of mathematics. In fact and obviously, it is not an abstract mathematics as we have today. However, their mathematics was more or less as concrete, and are part and parcel of their culture and or daily oriented activities concerning the management of their lives and cultures. (Yambi, 2004)

Yambi's exercises in Figure 2 illustrate well how people's local names and the references to the bridge parts make these appealing questions for a student from the local area. The third example is reflective of the likely people, position, activity, and instruction that would be undertaken during the construction of the bridge.

30° 10 m

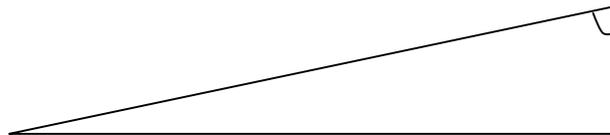
20m

Examples on angles

Example 1:

Kota Yarisi was at the top of the posts tightening the bars together during a cane bridge making. Sualo Nakisi was on the bridge, 10 meters away from the posts on the opposite side of the river. The distance from the bridge to the top of the bars is about 5 meters. Kota Yarisi looks down on Sualo Nakisi at an angle.

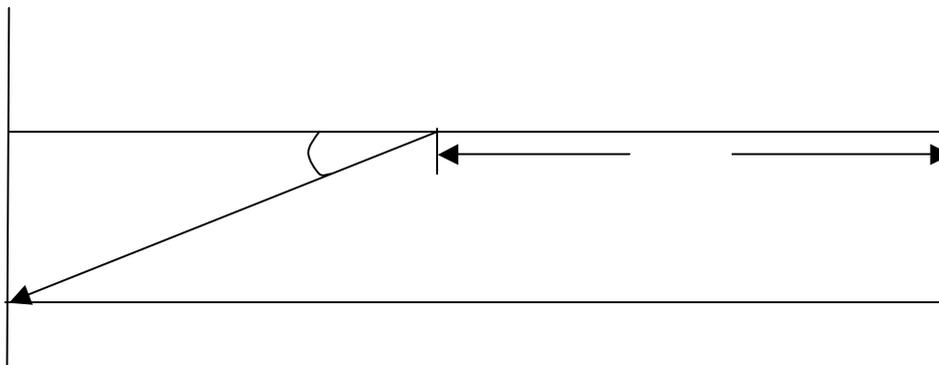
What is the angle of depression that Kota Yarisi looks down at Sualo?



Example 2:

Kulumburepa was walking on the bridge while his mother, Yalumita was at the foot of the bridge with her kaukau bags on the other side of the bridge. When Kulumburepa was at the center of the bridge at a distance of 20 meters away from the start of the bridge, his mother while at the foot of the bridge called his name so he looks down at his mother at an angle of 30° with respect to the path that he was walking.

What is the distance of the posts from its base towards (sic) the bridge?



Example 3:

Mambu Anda was sitting on the cross bars at the top of the posts tightening the supporting ropes of the cane bridge. While he was there, his “small uncle” Wapi Yamo, was waiting for him on the other side of the fast flowing Yalo River. The distance from the cross bars of the posts, where Mambu sits to the base of the posts is 15 meters and the distance from the base of those same posts to where his small uncle sits is 40 meters.

- Identify which is the angle of depression?
- What is the angle of depression that Mambu sees his uncle?
- What is the angle of depression if his uncle just moved inwards towards the bank of the river 5 meters?

Figure 2. Exercises on mathematics related to Kewabi bridge (Yambi, 2004).

A similar link with real experiences is found in the ratios for mixing paint in the next quote. It is a springboard for the questions. However, we are also perceiving how the teachers have been colonised by their own education in the way they have adopted questions that reflect textbook questions. Nevertheless, the descriptions and familiar names assist the student to imagine, draw, and solve the problems.

The *Telefol Tribe* is one of the unique and distinct groups of people apart from many who are living in the district of Telefomin, Sandaun Province, PNG. The cultural activity is about ‘*Constructing a Telefol Traditional Door Board*’ called ‘**Amitung**’. The height and the width are measured using bush ropes. The hollowed part of the door board is also measured by using a rope. A bush rope is used to measure around the waist of the fattest man in the village. Then the same rope is used again to measure the doorway of the door board. The circle is drawn on the wood for easy carving. (see Owens, this issue for a picture of this doorboard)

After the designs are carved on the wood, they used three different traditional colours to paint the designs that have been carved. The traditional colours used are; maroon called ‘**Baagaan**’, white called ‘**Buuguung**’ and black colour from carbon called ‘**Amsiring**’. To make the paint shiny and bright some grease pig [liquid pig fat] is mixed according to the correct proportion with the three traditional colours.

After all the work is done, the newly constructed door board is placed in front of the newly built ‘Haus Man’ known as the ‘**Knong Amm**’. This door board is used as a doorway in and out of the house.

The link between the traditional door board making and teaching the topic Ratio and Proportion.

Example: 1

Anivatok and Naatum decided to paint their newly constructed door board designs. They both had the three traditional paints to paint their designs on the door board. Before painting the door board, Naatum suggested that they should mix the three traditional colours with some grease pig before they can paint their door board. This is because when the paints are mixed evenly with the grease pig, the colours on the door board will be shiny and bright. And so they both agreed and started to mix the paints with the grease pig.

- The three colours are made bright and colourful by mixing each one of them with the grease pig in the ratio of 2:1 (two is to one). We are mixing all the three paints with the grease pig in the ratio given above to produce the correct brightness.
- The ratio 2:1 is in its simplest terms because there is no whole number that will divide exactly into both sides.
- If Naatum and Anivatok decided to increase the ratio of paints to grease pig up to 9:6. The ratio 9:6 is not in its simplest terms. What is it in its simplest term? (Onggi, 2005)

The geometry of the designs and of circles was relatively easy to connect to school mathematics in the rest of Onggi’s project while the ratio section illustrates familiar experiences and names. The introductions to each project expressed how students really felt

proud of their ancestors' knowledge but they also show how ethnomathematical approaches influences the two-way approach to mathematics (Davis & Grose, 2008; Stanton, 1994).

Conclusion

A democratic society is one where the majority opinion drives decisions. This results in the majority, colonising culture and western education dominating the school systems even in remote areas (O'Sullivan, 2011). Mathematics in particular is regarded as being one way without alternatives, dominated by western mathematics and perpetuated by a lack of experience with Indigenous systems. It is therefore important for the majority to understand the richness, diversity, feasibility, strengths, and links to schooling of Indigenous knowledges and education.

Democracies are also places where there is freedom of voice. However, we need to recognise the sociopolitical circumstances that in fact do not give minorities or Indigenous people a voice. It is only with deliberate effort and policies to encourage an Indigenous voice that ethnomathematics will be recognised. Furthermore, a study of ethnomathematics informs educators of different perspectives on ways of learning, different mathematical relationships, and different ways of viewing mathematics. Mathematics is part of a world view, and as such new ways of engaging students may be appropriate.

New skills may be valued by the community and in this case, it is the role of educators to ensure that there is dialogue between themselves and community Elders and other members. Each group brings their own expertise, knowledge and interests to the table. In our NSW areas, this occurs through Aboriginal Education Consultative Groups which democratically elect committees and involve community and school representatives including school principals. However, more informal discussions (yarn ups) must occur to develop trust and understanding in the search for meanings and connections between educators' and

community members' mathematics.

Studies have highlighted alternative ways of thinking about space and measurement (Owens, 2010; Owens & Kaleva, 2008a, 2008b; Pinxten, van Dooren, & Harvey, 1983) and other areas of mathematics (Owens, 2001; Paraide, 2008). This paper illustrates that these alternative approaches to mathematics can be incorporated into the curriculum through partnerships with Elders, consideration of language that contains the mathematical thinking of the culture, and approaches in which two ways can be incorporated into learning. In particular, the context for learning is a significant motivation for learning and a basis on which to understand the concepts of school.

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