Adult learning and oral culture

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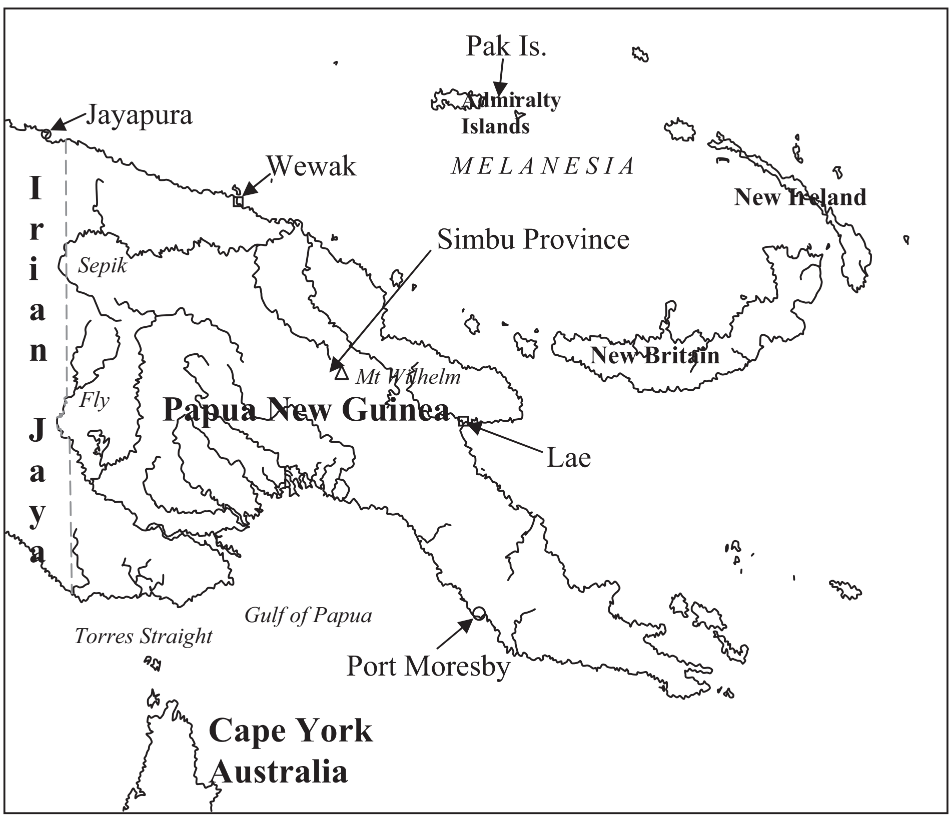
I have worked as an educator in Papua New Guinea for over 20 years. The major part of my role has been the provision of professional support of teachers and administrators. For the past ten years I have been working with Papua New Guinean teachers to improve learning outcomes in Mathematics for primary school children. Papua New Guinea has over 850 language groups spanning the spectrum of Melanesian culture 'bound' in their voluminous oral traditions. My presentation relates my experiences of knowing and learning among the people of these many and varied oral traditions. It considers Mathematics in Melanesian culture, teaching and learning styles and what seems to work with adults.

Papua New Guinea



Mathematics in Melanesian culture

I want to begin my presentation by paying tribute to the cultural mathematics of Melanesia and to one of its great champion scholars.

I draw on the words of Kay Owens (2001) to express my awe and wonder at Melanesian culture and its mathematics.

> Papua Niugini with its 800 languages and cultures is very rich. …. to think that (they might) feel as proud of their traditional maths as they are of their traditional dances and designs and kinship relationships.

Glendon Lean (1968 – 1989) was the champion of Melanesian Mathematics.

> Over .. 21 years he …… personally collected and documented more than 1,500 counting systems (in Papua New Guinea). His Ph.D thesis "*Counting systems of Papua New Guinea and Oceania*" documents over 2000 different counting systems in four book-sized appendices. (Alan Bishop, 1995)

The people of Melanesia have a truly awesome wealth and variety of cultural counting systems that are a living library of the development of the number systems of mankind. But for the work of Glendon Lean and now Kay Owens, few of us would know of these treasures.

About culture and mathematics

The term 'ethnomathematics' was first used in the late 1960s by a Brazilian mathematician, Ubiratan D'Ambrosio, to describe the mathematical practices of identifiable cultural groups. Some see it as the study of mathematics in different cultures, others as a way of making mathematics more relevant to different cultural or ethnic groups, yet others as a way of understanding the differences between cultures. But perhaps the most powerful claim for the new discipline has been made by D'Ambrosio himself (quoted in *The Chronicle of Higher Education*, 6 October 2000):

> Mathematics is absolutely integrated with Western civilization, which conquered and dominated the entire world. The only possibility of building up a planetary civilization depends on restoring the dignity of the losers and, together, winners and losers, moving into the new. [Ethnomathematics, then, is] a step towards peace.

Some people maintain that ancient mathematics systems are irrelevant today. This is unfortunate. Many non-Western mathematics systems remain 'alive'; some Mayans, for example, still use traditional calendars for religious purposes and to help determine the agricultural cycle. Most Melanesian languages retain the traditional counting systems in one form or another.

Moreover, Western mathematics does not meet the needs of all people and is not always easily understood outside the 'mainstream' culture. For years, Australian educators have noted that Western mathematics often has little meaning in remote Aboriginal communities and is therefore difficult to communicate. Approaches that take into account the cultural context and the mathematical systems in use within the community are likely to be much more effective

About Melanesian cultural mathematics

It is important that we remember the context in which the number systems of Melanesia were learnt and used.

Papua New Guinea is an oral culture, its heritage is held in oral traditions of story-myth, verse, song, drama and dance, art and sculpture. None of the traditional maths was associated with written symbols. At best it was recorded as notches on sticks or knots on ropes. Many of the systems used multiple cycles for counting. The systems ranged from limited (2,5) cycles to sophisticated decimal systems that enabled counts to over a million. The number names in some counting systems were related to body part names. A single language or cultural group sometimes had different counting systems for different purposes. The mathematics of the different cultures was integral to their language and relevant to their needs, for example, counting produce, trading goods, tracking seasons, and navigation at sea.

Analysing Melanesian counting systems

Counting systems can be classified according to their structural characteristics. Glendon Lean used the classification system developed by Salzmann (1950). For example:

> Let us suppose that we have analysed a counting word sequence to have the form: 1, 2, 3, 4, 4+1, 4+2, 4+3, 2×4, (2×4)+1, (2×4)+2, (2×4)+3, 3×4,...., (4×4)+3, 20, 20+1, 20+2, 20+3, 20+4, (20+4)+1, (20+4)+2,..., 2×20, (2×20)+1, (2×20)+2, ... i.e. there are distinct number morphs (names) for 1 to 4, and 20, and all other members of the sequence are composed of these.

The characteristics used by Salzmann to describe and analyse the counting systems are:

- *frame pattern* - the number morphs (names) (1, 2, 3, 4, 20) from which all other numerals in the sequence are generated, is called the frame pattern of the sequence
- *cyclic pattern* - the sequence has a cycle of 4 and a superordinate cycle of 20 denoted by the set (4,20) and
- *operative pattern* - of a numeral sequence is essentially a summary of the various number sentences which indicate how the complex number words in the sequence are composed

The *operative pattern* of the *Kewa* (EHP, PNG) system becomes apparent when we consider the semantics of the numbers 5 to 12 as shown in table 1.

Table 1. The Semantics of the 4-Cycle System of (East) Kewa

Hindu-Arabic	*Kewa* Number Word	Body Part Symbol
1	pameda	one finger
2	laapo	two fingers
3	repo	three fingers
4	ki	four fingers i.e. one hand
5	kode	the thumb, i.e. one hand and one thumb
6	kode laapo	two thumbs, i.e. one hand and two thumbs
7	kode rep	three thumbs, i.e. one hand and three thumbs
8	ki laapo	two hands
9	ki laapo na kode	two hands, one thumb
10	ki laapo kode laapo	two hands, two thumbs
11	ko laapo na kode repo	two hands, three thumbs
12	ki repo	three hands

The Wiru and Kewa 4-cycle systems (EHP, PNG) are not the only means of enumeration for these language groups. Both possess body-part tally systems, that for Kewa has a 4,7-cycle. The *operative pattern* of the *Kuman* dialect in Simbu Province (from personal contribution by Mrs Nicky Nombri – June 2005) 2, 5 – cycle system is shown in Table 2.

Table 2. The *Kuman* number system

Hindu-Arabic	*Kuman* Number Word	Body Part Symbol
1	suwara	(one finger)
2	suwo	(two fingers)
3	suwo ta	[2+1]
4	suwo suwo	[2+2]
5	suwo suwo ta (ongo koglo)	[2+2+1 or 5 (one hand)]
6	suwo suwo suwo (ongo koglo ta)	[2+2+2 or 5+1]
7	ongo koglo suwo	[5+2]
8	ongo koglo suwo ta	[5+2+1]
9	ongo koglo suwo suwo	[5+2+2]

These are but two examples of the enormous variety of counting systems in Melanesia. The variety of counting systems feature across both the Austronesian and Non-Austronesian languages of Papua Niugini and Oceania. Table 3 below (Owens, 2001) summarises the frequency of some 10 and 5 cycle systems in these languages.

Table 3. Frequency of 10 and 5 cycle systems.

System	Subgroups	Number
10 cycle	10, 100	182
	10, 20	20
	10, 20, 60	1
5 cycle	5 / 5, 20	142
	5, 10	134
	5, 10, 20	59

The use of a body-part tally system features in many Melanesian languages. The standard Oksapmin number system is an example of a body-part tally system. In the Oksapmin counting system, "… one begins with the thumb on one hand and enumerates 27 places around the upper periphery of the body, ending on the little finger of the opposite hand. If one needs to count further, one can continue back up to the wrist of the second hand and progress back upward on the body" (Saxe, 1999). See figure 1 below from Saxe (1999).

In this short presentation we only have time to wet your appetite for this rich treasure of mathematical history. We are here to consider how this rich culture may impact upon learning of mathematics in the context of modern times where the world and culture of these peoples have been invaded by Western approaches to everyday mathematics.

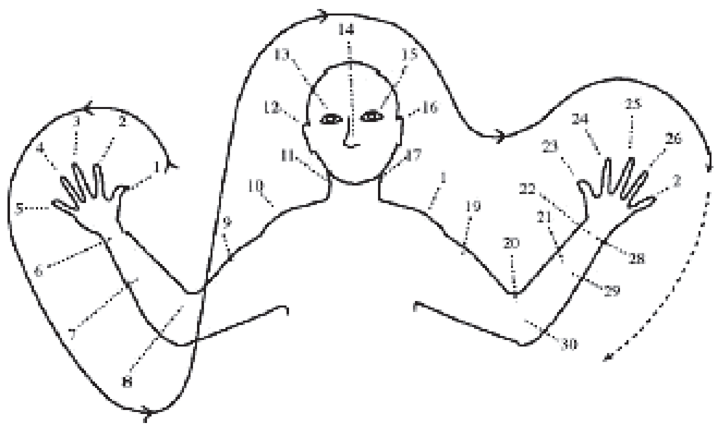


Figure 1. The Oksapmin body part counting system.

Teaching and learning styles

If we remember that Papua New Guinea's heritage is held in oral traditions of story-myth, verse, song, drama and dance, art and sculpture and that none of their traditional maths was associated with written symbols, then we might ask how they went about learning their numeracy, their Mathematics. Can we westerners ever imagine learning anything of importance and not recording it in written symbols.

In traditional Melanesian society people are taught and learn in everyday contexts. They learn the oral counting sequence and apply it to the different purposes requiring counting, for example during ceremonial exchange for marriage, birth, death, dispute resolution and for trade.

Some language groups, though few in number, record tallies using markings on sticks and bark or knots in ropes. Many groups use standard size groups or bundles for particular items for example, shell money rings in *Tolai* culture in East New Britain. Most cultures have some form of accurate measurement for construction of houses and canoes. They have systems for comparing the size of pieces of land such as gardens.

Many Island cultures are able to navigate the open ocean by the stars, wind and wave patterns. The use of wave patterns for navigation required a knowledge of the prevailing wind driven wave patterns and the refractive patterns caused by reefs and islands. The knowledge and skills used in these tasks were passed on as special knowledge and learned through experience.

I began pondering the impact of traditional culture when faced with a problem with the learning of Mathematics at my newly established school. The school was one of two schools fully staffed by Melanesian teachers who were required to teach the Western styled syllabus used in our system of schools.

I was faced by the dilemma that many of my students were not learning school maths. Upon working with the teachers during inservice sessions, I found that they too were poor at school maths. They didn't have a well developed understanding of the many concepts and thinking processes needed to solve basic problems. I found that my teachers were 'rote learners and teachers' of maths. They made no links between their cultural mathematics systems and the western maths they were supposed to teach. There was an obvious disjunction between the two worlds of these intelligent people, their traditional knowledge systems and the knowledge systems of their workplace.

I began to analyse what we do to people when they come into one of our western style schools which use English exclusively as the language of instruction (as I had done so many times before). This western style education makes little effort to link *school numeracy* to the learners' prior knowledge and culture and hence, in this case, fails to build on their understanding of cyclic counting systems. We make no reference to their familiar language systems and teach a Mathematics almost completely divorced from language, ever rushing to impose its own written symbol system.

We introduce Hindu-Arabic counting to these people as though it is something entirely new, different and a *foreign language,* thus rendering the awesome richness of their prior knowledge irrelevant. We create confusion for many because, for example, the naming of cardinal and ordinal numbers is both distinctive and gender sensitive in some traditional languages

When we western style educators quickly introduce learners to written symbols without them thoroughly knowing the oral counting sequence and its cyclic nature, counting becomes more associated with and confused by the abstract symbols. The situation is compounded because many teachers have poor a understanding of place value notation and little facility to use it mentally and so, as a result, the concept becomes poorly developed in their teaching.

Further confusion arises with the English number words for the *teen* numbers. New learners are confused because the names and symbols are inconsistent and do not reflect the place value system for the decimal counting cycle (see table 4 below). In traditional oral systems, there is no confusion with a complex notation system.

Table 4. Inconsistencies in English

Numeral	English Name	Systemic Meaning
9	Nine	Nine ones
10	Ten	One ten
11	Eleven	One ten and one
12	Twelve	One ten and two
13	Thirteen (three and ten)	One ten and three
20	Twenty	Two tens
21	Twenty one	Two tens and one

These are some of the obvious dilemmas we place upon our learners in our western styled education. Is it arrogant or not? It is certainly not always better.

What seems to work with Melanesian adults.

I have found that when working with Melanesian adults, that the place value notation system we use for representing the counting numbers is basically a mystery. Few have a clear and consistent understanding that can be matched with concrete application. I have had considerable success during teacher training and inservice programs in developing an understanding of place value by resorting to bundling and counting single and groups of objects using their Tok Ples (traditional language or *lingua franca*) and English. We then write the names and numbers in both languages and in Hindu-Arabic Symbols.

It appears important to me that very early in the education of everyone, we should revisit the learner's traditional or familiar counting system (or *tok pisin*) and highlight the cyclic nature of the counting sequence. This also builds a sense of being valued and of valuing culture. We must build the language within and around the concept of counting cycles using the language of instruction (English). We need to integrate numbers everyday into language instruction sessions so that our mathematics is seen as part of our language and not removed from it. It is important to link the traditional cyclic counting sequence to written symbols and place value notation using concrete materials to overcome the difficulty with abstract symbols. This is one way to make any similarities and differences explicit. We need to generalise the concept of counting cycles and place value notation to the Hindu-Arabic System. Probably most important of all is that we 'play' with large numbers of objects to develop a 'feel' for their magnitude (For example: count a large number of objects by bundling in tens).

An example of how I try to help generalise the counting cycles and place value notation to Hindu-Arabic System is to use counters to demonstrate how regrouping is used to solve the *base 5* task shown in figure 2.

I call this counting and adding by the *pentile people*. Many adults schooled in the columnar addition algorithm find the answer '32' rather baffling for some time. It certainly brings home the point about what happens to our young children when they go to school. Once they have grasped the addition, we usually do some simple subtraction and multiplication examples as well. We then generalise the thinking to the decimal system.

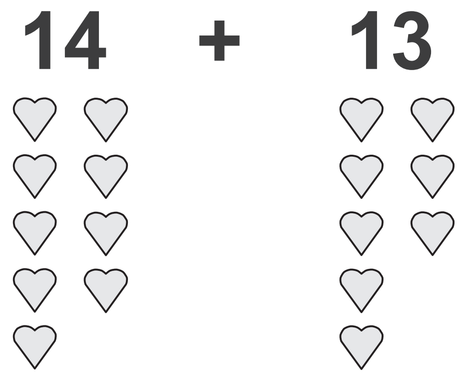


Figure 2. A task using pentile numbers.

A Melanesian perspective

Melanesians generally believe that special knowledge is something given to you to empower you. It is given by someone who has the authority to give and pass on that authority for you to use it. Common examples of knowledge that is bestowed in this way often relate to sorcery, lineage and land boundaries.

Western Mathematics, I believe, is often seen by Melanesians to be one of these special types of knowledge. It is perceived to have its own language and symbols that only those with the special 'gift' for and authority to use Mathematics are able to understand and use it beyond mechanically learned and applied facts and processes. It is seen to belong to the elite and privileged few.

This cultural perspective on the ownership of knowledge and the role that Western Culture bestows on Mathematics raises a serious equity issue:-

How can mathematics become knowledge that empowers everyone in society to participate equitably?

There are probably many who would disagree that Mathematics should empower equity, however I believe we need to. To achieve this end, it is necessary to separate the issue of mathematics and numeracy into two separate domains:

- *Basic Mathematics:* referring to basic mathematical (numeracy) concepts, knowledge, language and literacy that are used in everyday life. They are important to everyone to enable them, within and through their culture, to engage effectively in modern society. This Mathematics needs to be taught in schools in the social and cultural context of the students.
- *Applied Mathematics*: referring to the theorems, algorithms, language and literacy used for specific applications over and above everyday life activities. Very few people use formal algorithms and trigonometry in their daily living, for example, whereas they may or may not be important at their workplace. The type of Mathematics needed for the different applications, particularly for different work tasks, can be mapped and taught to those that use it when they need it, thus removing the *gate-keeper* role often played by Mathematics.

The reality in modern education is that seventy or more percent of school children do not effectively learn Western school Mathematics. We need to remove basic mathematical knowledge from the bounds of special knowledge and open access to Basic Mathematics to everyone. Leave the specialist applications of Mathematics to those that need it. Rather than teach everything to everyone, let us carefully map who needs to know what and when they need to learn it.

Some big ideas

In the context of pulling together my thoughts for this presentation, I reflected upon my work as an educator of teachers and learners. This work often leads me to ponder the implications of some of the familiar big ideas that have long been held important to the learning process. I think of:

- Gardiner – multiple intelligences and learning styles
- De Bono – ways of thinking

- Piaget, Diens – constructivism
- Vygotsky – Social context of learning
- Bloom – levels of complexity of cognitive skills

These big ideas tell us that people think about and perceive their world or their reality in different ways and at different cognitive levels. Our individual world has a social context that is part of wider culture made up of beliefs, knowledge and technology that we as individuals and as a community of people have constructed so that we can to live and prosper. As I think in this way, several principles appear to be important. If mathematics is going to be meaningful and accessible so as to empower the wider population rather than just the intellectual few, then we must:

- Respect the integral relationships between mathematics, language and culture.
- Respect the culture of all peoples' and their mathematics, be it different or not, as a relevant and important way of being in and perceiving the world.
- Respect and build upon the prior knowledge of learners.
- Value the need for people to know and understand both their Traditional (Owens, 2001) and Western Mathematics as tools for equitable participation in a global society.

Finally, I believe that the quest that is common to us all at this conference is to find out:

> How can mathematics become knowledge that empowers everyone in society to participate equitably?

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