Liberating developments in numeracy

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Numeracy: numbers, arithmetic or mathematics?

Have you heard of the book *Everything I need to know I learned in kindergarten*? Even if you have not, you might appreciate this story. My youngest son, on returning home from his last day in kindergarten, announced that he was quitting school because ‘I know my numbers and I know my letters’. What more was there to learn? In one sense he was already numerate and literate.

In French, which was the language of my children’s schooling, the word for literacy learning is *alphabetisation* and quite obviously ‘alphabet’ is the root of that word. So literacy could be knowing one’s alphabet or letters. There is no single word for numeracy in French. One might say ‘capacités de calcul’ or ability to calculate—the ability to add, subtract, multiply and divide. When a person is deemed ‘hardly numerate’, the French would say ‘*il sait à peine compter*’ or ‘he can hardly count’. So numeracy might be the ability to count or to calculate. The *Robert & Collins Dictionnaire Français-Anglais, Anglais-Français* (1987) dictionary translates numerate
as ‘qui a le sens de l’arithmétique’ so a numerate person is one who understands or has a feel for arithmetic. In this sense, my son, in graduating from kindergarten, was well on his way to being both numerate and literate.

In English, ‘numerate’ fares a little better. It comes from the Latin word *numerus* or number and the ending -ate is borrowed from literate. The *Concise Oxford Dictionary of Current English* (1990) defines the adjective ‘numerate’ as ‘acquainted with the basic principles of mathematics’ and the most recent editions of the American *OED* maintain this definition. This takes numeracy well beyond knowing one’s numbers and the operations on them; from knowing arithmetic to knowing the basics of mathematics. And this is the numeracy that has been my passion and my life work since it captured my imagination about five decades ago.

It is important here to make the distinction between arithmetic and mathematics. Arithmetic is a very tiny and, to many mathematicians, desolate area of mathematics, a moon in the universe of mathematics. One mathematician, in reflecting on school math, said:

> I sometimes wish schools would go back to using words like “arithmetic” to describe the content of “math” courses. Calling them mathematics debases the currency of mathematical thought; it’s a bit like using the term “composing” to describe routine exercises in playing musical scales (Stewart, 2006: 35).

Arithmetic has a very different (and more recent) history from the rest of mathematics. It flourished in the 15th century in Italy because of the needs of the new international trade. It is a product of the rise of capitalism, according to the publication *Capitalism and Arithmetic: The New Math of the 15th Century* (Swetz, 1987). Business people, or merchants as they were called then, flocked to the Italian ‘reckoning’ schools to learn—mainly through memorisation and drill—such exotic arts as the use of the abacus, the multiplication facts up to 99 x 99, division, discount and interest, calculation of area, fractions and money conversions. The first arithmetic textbook, *The Treviso Arithmetic*, was published in the year Leonardo de Vinci turned 26 and just fourteen years before Columbus
set sail to discover the ‘new world’—which in the history of mathematics was a very short time ago.

This chapter is about mathematics education, as opposed to arithmetic, looking at it from an international perspective. It is therefore about the international task of numeracy, of creating numerate communities in the richest sense. Whilst writing from the perspective of a member of an international mathematics education community, I recognise that every society has the task of defining for itself what the numeracy needs of the population are and how it will go about satisfying those needs.

Sometimes we need to remind ourselves about those needs; we need to ask ourselves: Why numeracy? Certainly there are the needs of the marketplace, the needs that led to the development of arithmetic, the mathematics of commerce and trade. And there are the needs of citizenship, of having the necessary mathematical knowledge to fully participate in one’s society, its debates and challenges. Mathematics goes beyond these to contributing to the development of what Paulo Freire (1972) termed ‘critical consciousness’, using the thinking tools of mathematics to analyse every aspect of one’s society, being the ‘critical friend’, seeing beyond the here and now. Mathematics provides a perspective on the world, a way of seeing, of thinking and communicating. And for many, it is a source of great intellectual pleasure, what Pappas (1989) calls The Joy of Mathematics, something that mathematicians might say gives them ‘a buzz’ or ‘a high’. Stewart (2006:33) describes mathematics as ‘the most creative activity on the planet’, and ‘something fascinating and beautiful, a way of seeing the world that is like no other’ (2006:10).

Whatever the reasons for choosing a particular level of numeracy for some or all of its citizens, societies need to consider seriously some of the recent international developments in the fields of mathematics and mathematics education if they want to make the best choices in curriculum and instruction. I have chosen four paradigm shifts in these fields that I consider are not only of major significance but are also liberating in their consequences for all those who are devoted to improving the teaching and learning of mathematics.
These four paradigm shifts or developments are:

- in the very definition or conception of the child-learner
- in the field of mathematics
- in mathematics education
- in the tools for doing mathematics.

In the following, each of these shifts and its consequences for the teaching and learning of mathematics is examined.

**The first shift: the definition of the child/learner**

Over the past century there have been many shifts in how we conceptualise children in general and most particularly children as learners. In mathematics education much research attention has been centred on how children learn mathematics. Only four decades ago, in some of the world’s most advanced societies, it was not uncommon to see curriculum and pedagogy in mathematics based on the definition of children/learners as empty vessels to be filled. The teacher’s job was to pour mathematical knowledge into those vessels, and the children’s job was to open their minds to all that was being poured in. Mathematical facts had to be inserted into children’s minds and retained by them through drill and practice until they could chant back the facts whenever prompted.

Research in child psychology and in particular the work of Jean Piaget—who often studied the development of mathematical concepts in children—led to a refinement of the concept of children as learners of mathematics. Curricula and pedagogy began to reflect the new knowledge of the ‘stages’ of intellectual development. In many places this new knowledge was fused to the old empty vessel model, taking the form of the concept of children/learners as vessels to be filled in appropriate developmental stages.

What Piaget and other researchers since Piaget were really pointing to, and what has now been acknowledged, was a totally new concept of children as constructors of their own knowledge. This constructivist definition represents a total paradigm shift away from the empty vessel model. In mathematics, it means
that children have to be put in a mathematically rich environment in which it is possible to build one’s own mathematical knowledge. Social constructivism—first developed by Vygotsky (1978)—recognises the collaborative nature of the learning environment, how knowledge is gained through communication and interaction with one’s peers and teachers, how all learning is social. The perception now is that children construct mathematics within a social setting and within a culture, with its language and other tools.

A rich example of this shift in the thinking about how children learn mathematics can be found in a survey of the literature about the teaching of algebra (Lee 2005). The developmental stages theory, as taught at teacher training institutes in most of the world, stress that children must first learn from concrete materials and operations and that abstract thought was only possible in early adolescence, or later for many. In mathematics, because counting and arithmetic were perceived to be ‘concrete’ and algebra to be ‘abstract’, it was concluded that children should start with arithmetic and proceed to algebra in adolescence, which roughly corresponded to high school. A corollary to this deeply held belief was that arithmetic provides the concrete foundation for the learning of algebra, that algebra is generalised arithmetic.

This belief was sustained and taught for decades, in spite of much evidence to challenge it. First of all, the majority of adolescents in the US hit a wall when they were introduced to algebra in high school. The failure rate was high, as was the drop-out rate in those school systems that allowed course withdrawals. Researchers were beginning to question the ‘generalised arithmetic’ view of algebra as well. Students who had done very well in arithmetic often struggled with algebra. Analysis of algebra itself was showing that it was so much more than generalised arithmetic. Some authors hinted that arithmetic was perhaps ‘an algebra’ but certainly not a strong enough example of one to base the teaching of algebra on.

In the 1980s a small group of researchers began to meet and exchange views about the problem of algebra in schools and how it could be addressed. They called themselves the Early Algebra Group and the slogan formulated by the catalyst
behind the group, Jim Kaput of the University of Massachusetts in Dartmouth, was ‘Algebra before acne’. Initially, the idea was to improve the success rate in high school algebra by preparing students for it in the later years of elementary or primary school. Pre-algebra was invented. As researchers in North America and Europe began looking at the algebraic work of younger and younger students, they discovered that even very young children were capable of engaging in algebraic thinking, i.e. making general statements about numbers, extending and expressing the general in geometric and numeric patterns, thinking about and working with unknown quantities, and even engaging in letter symbolic manipulation.

In 2001, at an international conference on the teaching and learning of algebra, the Early Algebra Group heard about and soon joined forces with another group of researchers (see Dougherty & Zilliox, 2003). These researchers were conducting curriculum development research in Hawai’i that was based on the belief that children are abstract thinkers first, and that algebra should precede arithmetic. These Hawai’ian researchers were adapting a Russian curriculum developed by Davydov (1975) and Elkonin, who had been influenced by Vygotsky rather than Piaget. The results of starting with algebra rather than arithmetic turned out to be quite spectacular. The mathematical achievement of students by the end of elementary school was as rich or richer in both arithmetic and algebra than that of many high school graduates in North America.

In recent years more and more young researchers are examining the flaws in the arithmetic to algebra belief and the concrete to abstract paradigm that underpins it. We are witnessing today the shift of a paradigm that is moving outside mathematics to other disciplines and to the whole ‘developmental stages’ theory that underpins it. Many curricula in North America and Europe are starting the learning of algebra in kindergarten or grade one. The National Council of Teachers of Mathematics (NCTM) has an algebra strand running throughout its mathematical Standards (NCTM, 2000). Textbooks (NCTM, 2001) and even teacher trainer texts (Carpenter, Franke & Levi, 2003) are being written to support this development. Few go as far as to introduce algebra before arithmetic but they do acknowledge that children can engage in and develop abstract thinking long before adolescence.
The basics of learning

We have seen in this example how a shift in paradigm about the developmental stages of a child’s learning was fueled by and contributed to a complete revolution in the teaching of school mathematics. Constructivist and social constructivist paradigms of how children learn are also profoundly influencing what takes place in classrooms. Globally we are moving away from the notion of the ‘universal child’ (who learns in developmental stages defined by research on young boys of a privileged European class). We are moving towards a child learning in a particular environment and culture with the language and belief systems that culture encompasses. What are the consequences of this international shift away from the ‘universal child/learner’ for the teaching and learning of mathematics in Pacific nations?

Consequences of the first shift

With the growing recognition of the capacity of young children for rich mathematical thinking, children are being liberated from the constraints of the standard or traditional mathematics curriculum with its strict hierarchy of learning concepts. Young children are now free to engage in abstract mathematical thinking—in asking questions like ‘Is that always true?’ or ‘Is there another way to do this?’—and to develop their natural capacity rather than let it atrophy until they reach high school, when it is often too late.

Just as there is no longer a universal child, so is there no longer a universal curriculum that will meet the needs of children in all cultures. A curriculum must reflect the needs, ways of knowing, and the learning tools (including language) of the culture in which it is developed. There is no ‘one size fits all’ curriculum. Mathematical knowledge is socially constructed by both mathematicians and learners of mathematics. From the scientific perspective, Pacific nations are freed from the curricula of former colonial powers, free to construct their mathematics curriculum to suit the needs of their children and, ultimately, their societies.

The second shift: unprecedented growth in the field of mathematics

Over the last few decades, the field of mathematics has been growing exponentially. This is not obvious to most observers because nearly all of mathematics is hidden in the objects that surround us. Not only is all technology founded on developments
in mathematics (from binary numbers to coding theory, Fourier analysis and the combinatorics of networks), almost every object in the world has mathematics hidden in it. ‘Your entire life bobs like a small boat on a vast ocean of mathematics’ (Stewart, 2006: 6), and much of that mathematics has been developed in the last 50 years.

If one looks at undergraduate and graduate university mathematics course offerings today and compare them to those of 25 years ago, one will see the results of that growth in the number of courses that would not have been possible then and, even if they had been possible, would not have attracted any students. To make room for the new topics, many traditional university or college mathematics topics have been dropped into the secondary curriculum or simply dropped. Students no longer learn the workings of the slide rule or how to extract cubic roots, for example. Topics such as complex numbers, solving systems of linear equations, differential calculus, and the beginning of linear algebra (matrices and determinants) have become part of the high school curriculum in many countries. Iterative processes, disdained by high school mathematics even a decade ago, have suddenly become important because the computer does much of its work with these. In fact many of the elegant and time-saving mathematics techniques have lost importance because the computer can do even the longest and most boring calculations in a fraction of a second.

**Consequences of the second shift**

With the ever-expanding new and exciting innovations in mathematics, and with mathematics responding to the needs of hundreds of other disciplines, it is impossible to address even a tiny fraction of mathematical concepts in school today. Furthermore, the themes we choose today may be obsolete or of little interest to tomorrow’s students. Mathematics educators are starting to come to the conclusion that it is not ‘what’ mathematics you teach but ‘how’ you teach it.

There are a number of mathematical processes that are important and can be learned through the study of any number of topics. Students today need to learn how to see the world mathematically, how to ‘mathematise’ their world, to see its patterns, and to think mathematically. They need to develop their mathematical problem-solving skills with an array of strategies and useful mathematical models.
The basics of learning

They need some skill in using important mathematics tools and—perhaps more importantly, given the availability of technological tools—knowing when to use them. Given the communication demands at all stages of mathematical work, students need to be able to develop their communication skills in the language of mathematics as well as the language of their community.

Once again, there is a liberation of the curriculum from some of the traditional topics that dominated the world’s mathematics classrooms. Since one can no longer cover it all, or even a significant sample of it, Pacific curriculum designers are now free to choose topics that have local richness and significance, topics which can be the object of mathematical problem-solving and communication in the classroom. Children are free to learn to mathematise their world rather than that of a foreign textbook world, which they often do not understand and cannot imagine. Global developments in mathematics have resulted in liberating the curriculum to focus on local mathematics, mathematical ways of seeing and knowing their own world—in this case, their Pacific world.

The third shift: mathematics education—another knowledge explosion

Up until very recently, it was believed that anyone who knew a certain amount of mathematics (the more the better) and a little bit about teaching in general, would make an excellent teacher of mathematics. In the USA, elementary teachers were given a little bit of basic mathematics and a lot of education courses, and high school teachers were often required to get a university major or minor in mathematics and one year of courses in education (history, psychology…) with perhaps one or two courses in mathematics education or, as they were often called, mathematics methods courses. In post-secondary institutions, it was assumed that a knowledge of mathematics was all that was necessary to teach it.

Yet the past three decades have seen an explosion, not only in mathematical knowledge, the second shift, but also in knowledge about the teaching and learning of the mathematics that dominated elementary, secondary and, more recently, college curricula up to the present. The field of mathematical didactics was born: the didactics of arithmetic, of algebra, of geometry, of statistics and probability, ratio and proportion—to name only a few. Hundreds of journals and
books suddenly appeared to handle all the research articles and their interpretation for teachers. Mathematics education associations, research groups, networks and departments sprang to life and multiplied.

There is today an impressive and growing body of research results around the learning and teaching of mathematics and, perhaps more importantly, an accessible collection of research tools and techniques that can be taken up by local practitioners to test the applicability or relevance of the research results locally.

**Consequences of the third shift**

The exponential growth of research into the learning and teaching of mathematics is beginning to change the way teachers are trained. Courses can now be offered to help teachers teach very specific topics in mathematics. As research has shown, knowing arithmetic and knowing how to teach children may not mean a teacher knows how to teach arithmetic to children.

Future teachers can learn to help students by analysing the errors they make and by knowing which ones are likely to occur. Rather than encumber the curriculum in teacher training, the growing body of research results can have a liberating effect on curriculum by integrating the learning of mathematics with the learning of the teaching of mathematics. Instead of a course to strengthen, for example, future teachers’ understanding of geometry and another course on teaching the elementary school curriculum, teachers can greatly enrich their understanding of geometry by studying the didactics or the teaching and learning of geometry in elementary school.

Teachers can learn to become researchers in their classrooms. Research results from Israel or Italy may not be directly importable to a Pacific classroom but the tools used in that research—the questionnaires, the interview protocols, the observation methods—may be. Freed from the tyranny of the universal child and armed with easily available research tools, Pacific educators can begin to forge their own body of research on how Pacific children best learn the mathematics they have chosen for their curricula.
The fourth shift: mathematics education—new technologies/tools

The mathematics we know is conditioned by the way our bodies and minds acquire it, hence by the tools and language we use to study it. Artigue (2002: 245) reminds us that “[t]he development of mathematics has always been dependent upon the material and symbolic tools available for mathematics computation”. When algebra, for example, progressed from rhetorical algebra to written symbolic algebra and, later, when it combined forces with the symbol system of Cartesian geometry to produce analytic geometry, great advances were made in all fields of mathematics. Earlier still, when Europe adopted the Arabic number symbols, another great leap forward was made. (One only has to try multiplying with Roman numerals or a base-60 number system to appreciate this.) New symbolic tools combined with material tools—from the abacus to the modern computer—and this not only accelerated the development of mathematics but also determined the kind of mathematics that would develop.

There has been a shift in paradigm in mathematics away from the old Platonic view that presented a unified mathematics with a real existence and mathematical knowledge as absolute universal and infallible truth. Platonists could not see the development of mathematics over time as being conditioned and changed by the tools they used. Mathematics existed and it was the job of mathematicians to gradually ‘discover it’.

We are now aware that many mathematics have developed in different cultures—some probably superior to our own. Today we have a fallible view of mathematics; we see it as a social construction over time, which just might have been better. What we have produced is the result of many forces—political and economical among others—but mostly the result of the state of development of our bodies, our minds and the tools we use to interact with the world around us.

… the only access that human beings have to any mathematics at all … is through concepts in our minds that are shaped by our bodies and brains and realized physically in our neural systems … the only mathematics we can know is … embodied mathematics (Lakoff & Nunez, 2000: 346).
The new information and communication technologies (ICTs) have not only changed mathematics; they are profoundly changing mathematics education.

The very use of ICT in teaching and learning mathematics changes the nature of the subject matter that we teach and learn, and challenges us as to what mathematics is. This has fundamental implications for what mathematics students should learn, and how mathematics should be taught. What it amounts to is a paradigm shift in the learning and teaching of mathematics. (Leung, 2006: 34)

Consequences of the fourth shift

Unhindered by the complexity of carrying out calculations (operations on large numbers, solving systems of equations, calculating statistical measures …) and the time required to do them, students are now free to explore new areas of mathematics and go deeper in their understanding of other areas. The new technologies—from the hand held calculator to the sophisticated computer software and web possibilities—are giving rise to a new and rapidly growing field of mathematics education research that is exploring the advantages and disadvantages of the educational use of the new tools. In Pacific schools, there is no need to wait for full access to the new technologies to begin to shift the emphasis away from calculating towards the much more exciting and enriching tasks of estimating and understanding the processes involved. We can be confident that, by the time today’s elementary school students reach the job market, the tools will be available and a different kind of knowing will be needed.

An often forgotten learning tool of mathematics, and one that is very important to Pacific learners, will be addressed in the form of a conclusion to this paper and a bridge to the literacy perspective.

In conclusion, the language tool

Although the tool of language is implicit in the discussion of the 4th shift, it merits being highlighted as it is probably more an issue in Pacific mathematics classrooms than is the advent of new technologies.
The basics of learning

The mathematics we learn is as much shaped by the language we use to study it as it is by any of the other material tools. Language shapes what we see and hence the mathematics we see in the world around us. If mathematics is a social construction then the language we use to think about it and to communicate it—both verbally and in written form—is bound to have a major impact on the shape of the mathematics we construct.

Studies are ongoing into mathematics as a language—a second language for everyone—and the nature of that language: its syntax or grammar, the interplay between its syntax and semantics, the differences between the formal mathematical language and the more natural languages of everyday communication. (See for example, Pimm 1987, 1995.) The interplay between the learner’s mother tongue and the language of mathematics (or the mathematics register) is the object of research and points to some major sources of interference between the two. In the mathematics classroom, increased attention is being paid to communication skills of all students, particularly of those who are being taught in a language that is not their mother tongue.

References


International Conference on Education. Honolulu, HI. Accessed from
http://hiceducation.org/proceedings_edu.htm
Leung, F. 2006. ‘The impact of information and communication technology on our
understanding of the nature of mathematics’. For the Learning of Mathematics,
school mathematics. standards.nctm.org
NCTM, Reston, VA.
IL.
Introduction

The purpose of this chapter is three-fold: firstly to present an indigenous perspective to mathematics and mathematics education, with particular reference to Fijian and other Pacific cultures. Secondly, the chapter draws parallels between the traditional perspective of the home culture and the formal classroom, thereby providing alternative pathways for meaningful mathematics learning. Lastly, the chapter links the discussions to the concept of numeracy.

The identification of a cultural perspective comes under the research programme called ethnomathematics, which acknowledges the different mathematical ideas and ways of ‘mathematising’ in different cultures. In this way, ethnomathematics allows for parallels to be drawn between the traditional and the formal classroom perspectives. The cultural perspective sees mathematics as a cultural product that is born and developed in answer to human needs, and is something that people do and use meaningfully. However, the identification is defined by the
conventional decisions of ‘what is mathematics’ and what activities and processes can be deemed mathematical. Specifically, the paper attempts to focus on four key activities: counting, measurement, locating, and making patterns and designs. The mathematical ideas described in this paper are different but complementary to formal mathematics in that they serve the same mathematical purpose.

Numeracy is a more holistic and applied notion of school mathematics. It focuses attention on being able to use mathematical knowledge to solve practical, everyday problems. Thus, a numerate society is one that is empowered with life skills, including numeracy, to make effective decisions. Much of primary school mathematics resonates with the notion of numeracy. This paper proposes that the background knowledge of the students, particularly at primary level, should be an important component of the curriculum, and learning experiences must be based around those knowledge areas to ensure that learning is built from there.

**Background**

The traditional Micronesian story of a group of fishermen sailing a canoe to the moon (Phillips, 1998) has been retold many times over. It goes like this. One evening, as five men sat in their canoe waiting for the fish to bite and enjoying the stillness of the evening, they were drawn to the full moon out there on the horizon. With a strong sense of purpose the men pulled up anchor and paddled towards the moon. After some time, they realised that they were not getting any closer because the moon had started to rise in the sky. They stopped, looked up and decided to aim the canoe, not at the horizon, but upwards at the moon. But this required them to shift positions to the back, so with the canoe pointed upwards, they continued to paddle.

The Pacific is a very large geographical region with many small islands scattered over 30 million square kilometres of ocean. The total population of the region is about six million and the lives of many revolve around activities and processes related to the sea. Since colonisation, the people and communities have been on a journey to new horizons and inevitably the Pacific communities have become part of the bigger global community. The promise of ‘bigger and better’ held an appeal
The basics of learning

for individuals, families and communities, and education was embraced as part of the search for the key to a vaguely-conceived new level of welfare. However, implicit in formal schooling was a hidden curriculum that made us believe there was little of value in our communities that might be useful in the modern world.

The education systems of most Pacific Island countries (PICs) are a legacy of centuries of European and colonial experience. Formal education was introduced through the Christian missions in the early 1800s and later maintained under the control of colonial governments. A dominant feature of education at the time, and one that is perpetuated today, is the imposition of imported academic curricula in our schools, mainly from the United Kingdom, New Zealand and Australia. As Thaman (1990, 1995) suggests, this has meant the promotion, both implicitly and explicitly, of the dominant values and ideologies of European cultures, even though some of them are antithetical to the beliefs and values of our own societies. Eurocentric control in postcolonial Pacific is subtle in the way values and ideologies are promoted through the concepts of universalism and naturalism.

In mathematics education, the knowledge and language of the English tradition dominate the curriculum and are presented as necessary for participation in the new global economy and market. This vision of linking the interests of our peoples with the wider economy seems to have justified an academic and mechanistic curriculum and, in turn, marginalised the knowledge and languages of traditional societies. The latter are deemed necessary, although they impinge only peripherally in the academic context.

All in all, the journeys of Pacific peoples into horizons of promise have been challenging. We have gained in some areas and lost in others. We still have our eye on the best of the global but, like the Yaap fishermen, we have to sail in our canoes that define who we are and what makes sense to us. Global education must recognise the sacredness of our cultures. This chapter proposes that as part of the global community we can affirm that condition. We can make the distinction between multicultural understanding and global education (Banks, 1989).
The state of mathematics education in Pacific Island countries

For an understanding of what I believe is the current state of mathematics education in most PICs, I wish to relate two experiences. In 1998 while attached to the Curriculum Development Unit (CDU) in Suva, Fiji, I was part of a visiting advisory team to one of the outer islands. Teams of officers from the CDU toured the schools regularly to conduct professional development and training for teachers and other stakeholders, to monitor and assess progress, and to offer advisory and support services. On the last evening of our week-long visit to this island, we held a combined question and answer session with all primary and secondary teachers. When it was my turn, one of the head teachers had this question about language and symbolisation for me: ‘When you want students to do a subtraction like 235−116, do you say 235 minus 116 or do you say 235 take away 116?’

I was surprised at the question and totally unprepared for it. I had never taught at primary school but I faintly recall some of my own learning in primary school many years back. I responded very cautiously and said I did not think it mattered which term was used as long as students understood the meaning of the concept of subtraction. I was then directed to the primary mathematics textbooks which specifically use the term minus. Apparently minus allows for ‘borrowing’ when one of the lower digits on the minuend is smaller than the corresponding digit on the number being subtracted; this is not so with take away, which could be confusing and also lead to errors. This was a case of an incorrect or partial understanding of particular words within the mathematical context, which made me realise how carelessly we use words in the mathematics classroom and create learning problems for students who are learning in a second language. I agreed with the need to regularly negotiate the meaning of words and symbols within the mathematics classroom.

Still in the context of ‘going by the book’, I could not resist the suggestion to develop in students an understanding and a feel for numbers so that they are comfortable with estimating and using invented strategies before attempting the algorithms. An example is if students were able to call up ‘nice, round’ numbers, say 240 and 120, rather than 235 and 116, carry out the subtraction operation
and then compensate by adding or subtracting the extra units to arrive at the answer. I also mentioned that place value notation could clear the doubts about whether you need to ‘borrow’ or ‘carry’ and when you do not need to do so. The teachers appeared to agree with me but I suspected their minds were still focused on correct ‘book’ methods that earned the marks in examinations.

The second story is one that I heard. It was about a university professor and his research experience in Papua New Guinea (PNG). He related this conversation he (B) had had with a university student (St):

B: How would you find the area of a rectangular piece of paper?
St: Multiply the length by the width.
B: You have gardens in your village. How do your people judge the area of their gardens?
St: By adding the length and the width.
B: Is that difficult to understand?
St: No, at home I add, at school I multiply.
B: But they both refer to area?
St: Yes, but one is about the area of a piece of paper and the other is about a garden.

The professor drew two rectangular gardens on the paper, one bigger than the other:
B: If these two were gardens, which would you rather have?
St: It depends on many things, I cannot say. The soil, the shade …

The student’s answers indicate the depth of mathematical understanding in his society. For him there is much more to deciding land issues than mere size. Fijian society, like that of PNG and others in the region, has an education system that is different in some respects from formal education. For Fijians, learning is purposeful and practical; it is contextual, domain-specific and cooperatively organised. The primary aim is the preparation of the young for life in society. They live their learning by participating in social functions, activities, and everyday life processes under the guidance and watchful eye of families, elders and the community at large.
The PNG student, like most of us, straddles two mathematical traditions. However, this example clearly shows the power in traditional ideas that are lived and make practical sense. There is no denying the student’s affinity for his home knowledge. But note that he does not forget the school knowledge, which is remembered exactly as it was given—a rule for computation, devoid of context. It is unfortunate that the student has had to carry the extra cognitive load of two methods, adding (e.g. 4+4+4+4) and multiplying (e.g. 4x4), which are one and the same but presented differently. The examples discussed here summarise, to some extent, the flavour of the mathematics taught in our schools—mathematical truths with skills to be mastered. The misconception that mathematics is universal and the same for everyone across the globe has justified the didactic, abstract way that teachers teach mathematics through the use of rules, formulae, symbol notation and algorithms. Teachers perceive mathematics to be absolute, and the curriculum and examinations mirror this view.

Changing notions of mathematics

In many PICs, the relatively poor performance of students as evidenced by national mathematics examination results, students’ resistance and apathy towards the subject, and low enrollments in advanced courses have been cause for concern. Time and again it is the quality of teachers and teaching that have been called into question and the response has been to improve teachers’ professional capability. While there is probable cause for this and any attempt at improving teaching is a good thing, it is my view that the issue is a lot deeper. The concern is not only: What is the best way to teach? but also, and more importantly: What is mathematics really about?

Every time I ask trainee teachers this question the response is the same—silence and wonder. It is as if mathematics has no links to issues of belief. Dossey (1992:36) thinks otherwise, suggesting that:

The perceptions of the nature and role of mathematics held by our society have a major influence on the development of school mathematics curriculum, instruction and research. The understanding of different
conceptions of mathematics is as important to the development and successful implementation of programs in school mathematics as it is to the conduct and interpretations of research studies.

Our concept of a universal mathematics is defined in mathematics texts and our learning in mathematics lessons. Our definitions of what constitutes mathematics are mostly about numbers, calculations, and solving problems. With ongoing difficulties faced by students in making meaning in mathematics classrooms and the high numbers opting out of mathematics-related studies, research and scholarship have pointed to new understandings. A significant development was the emergence in the 1980s of a powerful new perspective on mathematics education—the cultural perspective (Bishop, 1992). Bishop saw this development as partly in response to national commitments to ‘mathematics education for all’. ‘The emergence of the cultural perspective challenges the provisions of homogenous curricula’ (Bishop, 1992: 169).

**What is numeracy? What does it mean to be ‘numerate’?**

‘Numeracy is to mathematics as literacy is to language’ (Steen, 1990: 1). The concept of numeracy and the word itself is British (Cockcroft, 1982); some American groups prefer to use terms like ‘mathematical literacy’ (MCATA, nd) and ‘quantitative literacy’ (Steen, 2007) to describe the same context of the work. Like mathematics, numeracy is a contested term (Zevenbergen, Dole & Wright, 2004), and in many spheres the term is used interchangeably with mathematics. Different sections of the community have their own definitions of numeracy. Some see it as ‘an ability to calculate’, thus relating it to arithmetic. Others relate it to the study of numbers only. Both these definitions are restricted. The Cockcroft Report (Cockcroft, 1982: 11) gives a more encompassing description by equating numeracy with ‘an ability to cope confidently with the mathematical demands of adult life’. This includes both the ability to perform basic arithmetic operations and to also use them confidently in practical everyday situations.

A similarly inclusive definition is used by the Australian Association of Mathematics Teachers (AAMT, 1997: 13): ‘the knowledge and skills needed for informed participation and decision-making in the world beyond schools’. The notion is of numeracy as a life skill that is important for living in the contemporary world.
The Cockcroft Report (Cockcroft, 1982: 11) defines two attributes of numeracy. The first is number sense or ‘at-homeness’ with numbers and the ability to use mathematical skills in everyday life. The second is an ability to appreciate and understand mathematical presentations, as in graphs. ‘Taken together, these imply that a numerate person should be expected to be able to appreciate and understand some of the ways in which mathematics can be used as a means of communication’.

In the New Zealand context, to be numerate is ‘to have the ability and inclination to use mathematics effectively at home, at work and in the community’ (Curriculum Update, 2001).

Zevenbergen et al. (2004) suggest that the current use of the term numeracy is politically motivated. The high number of students leaving school with a negative view of mathematics and poor mathematical skills has raised questions about the value of core school mathematics. Enter numeracy, which is a more holistic and applied notion where students would be expected to use and apply knowledge to solve practical, everyday problems. Many primary curricula resonate with the notion of numeracy.

As our societies are increasingly being driven by science and technology, they have become more complex. The infiltration of global communication and international trade markets has raised minimal levels of numeracy. The demands for numeracy are as high as those for literacy. A glance at our local newspapers reveals numerous examples of mathematical representations, as citizens are continually being bombarded with information expressed in numbers, rates and percentages. News items of the consumer prices index, gross domestic product, interest rates and many other statistical measures are common. Newspapers and the media in general expect readers to be well versed in basic mathematical ideas and computations and how these apply to various levels of the economy. The computer age has spawned not only an explosion of data but also new language forms that demand new understandings. Steen (1990: 2) rightly asserts that numeracy is not a fixed entity but is continually changing. The standards have changed and will continue to change.
As PICs face the daunting reality of having to compete in a global economy fueled by information technology, they are quickly realising the importance of a numerate populace. While expectations have increased tremendously, the same cannot be said of students’ performance. The demand is for people with a high level of both literacy and mathematical ability. It is not far-fetched to claim that mathematical ability (and numeracy) is the gatekeeper of many desirable jobs and provides an edge in successful participation in everyday life.

**What does this mean for students of Pacific Island countries?**

School mathematics is the main vessel of numeracy. Unfortunately for us, it is also the source of innumeracy. In PICs, mathematics is a status subject which, together with English, serves as a filter to many sections of a workforce that has become increasingly technological. Because mathematics is considered a sequential subject in most of the PICs, and because many sciences require a mathematical background, students are encouraged to take it throughout their schooling. However, the relatively poor performance of our students as evidenced in mathematics examinations, low enrolments in higher mathematics, and students’ observed resistance and apathy towards the subject are causes for concern.

Steen (1990: 7) offers good advice:

> Many trades and professions keep their numeracy standards high in order to select individuals with a certain quality of mind (or, critics charge, of a certain socio-economic status). So long as this is the case, prudent educators will require young students to continue their study of mathematics not because they *will* need it but because they *may* need it. The consequences for a student’s economic future are too serious, and the temptation to opt out of a difficult course too great, to justify electives as wise mathematics policy for students who are still in required school.

**Action plans**

Approaches to numeracy vary. In Australia there is a National Numeracy Plan (see: [http://www.griffith.edu.au/school/cls/clearinghouse/](http://www.griffith.edu.au/school/cls/clearinghouse/)) which highlights the federal government’s policy framework for school numeracy education and for the
enhancement of numeracy outcomes for all students. In addition, each state has
developed state and school numeracy plans and goals for achieving standards of
numeracy and literacy.

In New Zealand numeracy receives attention at national level and is being reflected
in national policy and research agendas. The New Zealand Numeracy Project (see
http://www.tki.org.nz/r/literacy_numeracy/num_materials_e.php) is a nation-
wide professional development initiative which introduces teachers to a new
approach to the teaching of mathematics. The focus of the Project is ‘improving
student performance in mathematics through improving the professional capability
of teachers’. Te Poutama Tau is the project arm that is particularly dedicated to
strengthening numeracy in Maori medium schools. The numeracy projects in New
Zealand and Australia have relied on very substantial funding.

It is suspected that in most PICs numeracy remains embedded in the mathematics
curriculum and arises out of mathematics teaching. It may be true that the school
curricula in the PICs do not as yet deal widely and uniformly with the topic. As
I described earlier, ‘going by the book’ and adherence to the rules and methods
for calculating are still prominent, even though some advances are being made
to encourage problem solving and mental strategies. The new Cook Islands
curriculum documents have made significant mention of numeracy; while still
primarily with mathematics it is also expected to develop within contexts of other
learning areas. Fiji is undergoing educational reform and a National Curriculum
Framework is progressing into development of specific learning areas; numeracy
is embedded in the mathematics curriculum.

PICs stakeholders must make a concerted effort to make numeracy a reality. Teachers
and teacher associations, parents and parent bodies, school systems, governments
and whole societies must affirm their commitment in a unified approach to
numeracy. This must begin with a re-examination of school mathematics, what
basic skills are important and how effectively these can be developed during the
years of schooling. Another important area is the need to integrate mathematics
across all subject areas, thereby increasing understanding of the pervasiveness of
mathematics in all aspects of society.
The terms culture and mathematics carry different meanings when perceived by different people at different times. Both terms carry meanings that are broad at one end and precise at the other. Students of mathematics, especially pure mathematicians, would strongly resist the idea of establishing a relationship between culture and mathematics, mainly because they see the study of mathematics to be concerned with high order thinking, removed from physical influence. For this reason, school mathematics is perceived as being independent of a student’s background and culture and should therefore transcend any cultural diversity (National Research Council, 1989). However, evidence from anthropological and cross-cultural studies demonstrates that mathematics is a cultural phenomenon and that other cultures have created other mathematics. Ethnomathematics is the study of mathematical aspects of the ideas and practices of cultural or social groups (D’Ambrosio, 1985). Bishop (1988) developed a framework of six universal activities, namely counting, measuring, locating, designing, playing, and explaining, which he perceived as necessary pre-conditions for the development of mathematics in any culture. Here is a description of some representations in PICs.

Counting

Glendon Lean, who drew attention to and collated data on the rich diversity of nearly 900 counting systems in Papua New Guinea and Irian Jaya, also suggested that systems based on body parts and cyclic systems developed spontaneously (Owens, undated,a). This diversity is evident when questions such as the following are asked: What are countable objects? When are they counted? Which economies and exchanges use counting? Are different types of objects counted in different ways? Are all objects counted? How are totals recorded? An analysis of the counting systems of PICs on the basis of these questions would show differences as well as similarities. In Owens’ (undated,a) description of some of the case studies of PNG and Papuan societies, we can identify some degree of similarity with other Pacific systems. Some of the descriptions are:

- the extensive use of numbers in ceremonial contexts, as in Tongan society
- the tendency to count a wide variety of objects
Kiribati counts items using various numerical classifiers such as flat objects (-baa as in wanibaa), objects that are containers (-kuo as in nimakuo), moving objects (-waa as in waniwaa).

- placing little importance on counting, despite a 10-cycle system emphasising the indivisible mass of a visual display, as in most Pacific societies
  Fijian society has a way of counting items of food and wealth used in traditional presentations in tens. Otherwise, in everyday circumstances, Fijians do not see the value in counting, do not like to count, and do not think it proper to count.

- the generation of arbitrarily large numbers, even though the people do not count large numbers
  The Tongan system, which has single terms for numbers from taba (one) to kilu (one hundred thousand), as well as the system in Choiseul, Solomon Islands, where people traditionally count using Jijiru—which organises counting in multiples of ten: mano (ten), karabete (twenty), tulununu (thirty), etc.—may be related to this.

- that fractions, except for half, are generally not used
  In Fijian society the only fraction that has a single term is veimama (half) while all others, if used, are part of the whole number. There is a tendency to perceive the whole and not the part, seeing ‘all or nothing’.

Lean’s work and learning about different counting systems demonstrates the fact that people invent mathematics and that this is a culturally developed phenomenon. In its own way, it also gives the base 10 place value systems more meaning (Owens, undated,a).

Measurement

Measurement is concerned with comparing things according to a shared quality, and it is done through the use of convenient units and standardised systems of units (Bishop, 1988). Tonga, Solomon Islands and Fiji measure using body parts, specifically the arms and legs. Dimensions of length are designated body parts and the main length units are the hand span (Fijian caga, Tongan banga); arm span (Fijian katu, Tongan ofa); shoulder length (taba) which is part of an arm span; and the stride (kalawa).
Measurement using body parts is a common activity in Fijian homes and Fijian students are very familiar with the body part measuring system. Versions of hand span measure the designs in mats and *tapa* cloth, while arm spans are used for the longer lengths of living room mats and *tapa*, and for farming and house building. A special application of the hand span is used by rice farmers to measure the distance between rice shoots when planting. Bent over and with knees deep in rice paddies, farmers would hold rice shoots in one hand and use the other to measure hand span intervals between each shoot. Since students, especially those who live in rural communities and the islands, are familiar with measuring by body parts, it makes sense to include these in the curriculum and also develop benchmarks that give them formal meaning. To ignore these informal measures and drive only the standard metric units is both naïve and a recipe for disaster.

Many Pacific societies estimate consistently and use estimations with descriptive forms and gesture phrases. In Tonga, for example, *fakasuofua* or estimation, is purposeful, and the language nicely discriminates the different usage. The degree of estimation in traditional societies would make students good estimators. Similarly in Fijian society, precision does not fit with our economic system and way of life and the Fijian language uses various forms of descriptive and gesture terms and phrases in place of numerical classifiers (Bakalevu, 1998).

**Locating**

Locating emphasises the spatial geometry of position and controlled movement (Bishop, 1988). Spatial orientation is discussed early in mathematics and concerns one’s position in relation to other things in the environment. In the cultures of many PICs, naming places is important to designate precise locations, so maps and graphs are important items of learning. Deacon (in Ascher, 1991) studied on the island of Malekula in Vanuatu and collected remarkable material that demonstrated ability and evidence of abstract thought. He reported (in Ascher, 1991: 64) ‘the amazingly intricate and ingenuous’ geometrical figure drawings in the tradition of tracing figures in the sand. The drawings, called *nitus*, are made in the sand by men, and ‘the figure is to be drawn with a single continuous line, the finger never stopping or being lifted from the ground, and no part covered twice. If possible the drawing is to end at the point where it begins’ (Deacon in
Ascher, 1991: 45). The patterns of drawings are accompanied by stories. As the story develops, the pattern changes, the story always ending in the same place as it began. All *nitus* have traditional meanings. Mathematically they vary in complexity from single closed curves to having numerous vertices, some even with degrees of 10 or 12. Symmetry, including rotational and line symmetry, is an important property common to most *nitus*.

**Designing**

We see shapes all around us and it is easy to find representations of geometry. Properties of shapes are always fascinating to students if parallels can be drawn with the environment. There are excellent geometrical representations in the everyday and communal tasks and activities of both men and women. For men, building a house, be it a Fijian *bure*, a Samoan *fale*, a Kiribati *maneaba* or a rectangular house in PNG, will introduce properties including symmetry, triangles and rectangles, and diagonals. The roof structures alone would bring up items of linearity and direction—horizontal lines, perpendicular and hypotenuse (Owens, undated, b).

For the girls, designs and patterns in embroidery and in the making of mats, baskets and *tapa* cloth and provide similar parallels. Mat and basket-weaving, popular tasks in all PICs, requires mathematical notions such as counting (strips), estimation, symmetry (of patterns), diagonal and perpendicular (weaves), and periodicity. The patterns in the weaves, especially in the design of *tapa* cloth (Tonga and Fiji) make excellent contexts for learning different aspects of geometry, especially transformational and rotational geometry. The intricate patterns of the *tiwhaiwhai*, or embroidered patched cloth, are unique to the women of the Cook Islands.

**Cultural ideas in the curriculum**

‘The choice of a curriculum … is a political choice’ (Mellin-Olsen, 1987: 16). Mellin-Olsen warns that the different uses of mathematics in cultures can decide whether the members of those cultures learn the mathematics of a curriculum or not. We can turn a blind eye to the relevant mathematical ideas in our cultures and go on as before, or we can acknowledge the differences between the competing mathematical traditions and the impact of possible conflicts in our children’s
mathematics learning, and make the necessary changes. I will use Robitaille and Dirks’ (1982) curriculum model that was founded on certain positivist assumptions and focused on three levels of the curriculum—the intended, the implemented and the attained—to assess the cultural perspective on mathematics education (Bishop, 1992).

**Intended curriculum**

The intended level of curriculum is that planned at the national level by curriculum committees and consultants and codified in the curriculum guides (Robitaille and Dirks, 1982). The planned curriculum can be done at the national level from a central education authority, such as the Curriculum Development Unit (CDU) in Fiji, or it can be at a local level from an informal cluster of schools. Then there is the planning at the school level where a head of department may develop schemes of work for use by a group of teachers to help them work towards common goals (Begg, 1994). At a more personal level, individual teachers develop lesson plans from the larger scheme of work. Traditionally, most intended curricula ignored the human aspect and presented mainly universalist thinking. In multicultural societies like Fiji, the critical question has often been: Whose cultural knowledge should be used and why? Unfortunately the result is the sanctioning of a culturally neutral mathematics curriculum; Bishop (1992) labels it a ‘culturally blind’ curriculum.

I glanced through a few mathematics curriculum documents from the region and was delighted at the evidence of a change in thinking. The Cook Islands Tree of Learning is a powerful representation of their core values in formal learning. ‘The Tree symbolises the Cook Islands people’s close connection and affinity with nature and the land, their bond to spiritual beliefs, and their relationship to economic well-being’ (MOE, 2002:2-3).

Fiji’s curriculum framework is saying all the right things; I was particularly delighted to read this statement, vague as it is, on the mathematics page: ‘Students will appreciate the wider use of mathematics in the different cultures, for example ethno-mathematics’ (MOE, 2005: 18). To make this work will be a challenge and Fiji will need the wisdom and skills of elders and experts for an understanding of traditional practices, knowledge and values.
The ‘rich tasks’ approach to curriculum that is being trialed in Nauru is unique and deserves mention. Nauru’s education system not only believes in sound educational theory but also in it being ‘grounded in the context of Nauruan culture and language’ (Department of Education, 2005: 1). Nauru rich tasks began as teacher practice tasks where teachers learnt to develop and use tasks to organise curriculum content. The Nauru document describes rich tasks as learning and assessment tools; they have quality standards built into them and, at present, a few rich tasks are used each term. The rich tasks balance the curriculum across all important areas. For example, *Growing up: maturing as a Nauruan teenager* is a Year 10 task and subject teachers develop lessons from it. The result is an integrated, holistic view of learning and knowledge. That the tasks are built on life in Nauru is a bonus.

**Implemented curriculum**

The implemented curriculum (Robitalle and Dirks, 1982) is the curriculum of the various texts and materials which are selected and approved for use in the schools, and communicated to students by teachers in their classrooms. This is the taught curriculum. Bishop (1992) suggests that the greatest impact of culturising mathematics can happen in mathematics classes through culturally responsive teaching. The important role of the teacher cannot be overemphasised. As Thaman (1997: 14) rightly suggests, ‘[a] new curriculum is only as good as the teachers who implement it because the quality of interaction between teacher and pupil is a critical factor in the latter’s ability to achieve’. Even if the content of the mathematics curriculum is rigid and defined, as it usually is, the context of teaching is open and teachers can negotiate and interpret it to suit their learners. The quality of classroom interaction is manifested in how much of the students’ background is included in the learning experiences teachers create and structure. The view of teachers as a cultural bridge fits well with this perspective.

Since most Pacific teachers would have been influenced by western ideas through imported curricula as well as foreign instructors, they would normally teach in the way they were taught. For a change in teachers’ perceptions of the nature of mathematics as well as their practice, important changes must happen in teacher education. Teacher education programmes have an obligation to foster new
conscoutrust of learning consciousness in teacher trainees. They must prepare teachers to be able to move flexibly and sensitively between both traditions, and help their students do the same. Using mathematical knowledge which is culturally informed, that students can use and relate to at school, at home and in the community, is the ideal way to go. This is the ideal way to empower students to become numerate.

**Attained curriculum**

This is the level of curriculum that is defined as that ‘learned and assimilated by students’ (Robitaille and Dirks, 1982: 17). Begg (1994:196) says that the amount of learning that may occur is strongly influenced by the ‘learning activities and the learning environment’ created and controlled by the teacher. He saw the attained curriculum as the critical one because ideally it is similar to the planned one. Therefore, if the intended curriculum was culture-blind then it follows that a culture-blind attained curriculum would result from it.

All things considered, it would seem sensible to make a concerted effort on two fronts: firstly at the initial planning and development stage where the indigenous voice must be strong, and secondly at the teacher training level where courses must incorporate aspects of learning about the culture and language of society. A vital part of this training will be to assure parents and teachers of the important contribution of local knowledge and language to students’ understanding of the perceived ‘universalistic’ ideas of formal learning.

**The language issue**

Mathematics is a powerful language of communication, a kind of hybrid language comprising ordinary English and mathematical English. The unique mathematical register and specially written form of mathematical texts can create confusion and difficulty in understanding mathematical problems and discourses. While for English speakers a mathematics lesson is generally a language lesson within the mathematics part, the situation is more complicated for students who have to verbalise in English as a second (or third or fourth) language, and also master the special mathematical register. The lack of a full mathematical lexicon in the local language registers makes the second step very difficult. Teaching in contexts relevant to the learner will help understanding. In the Pacific Islands, attempts to
develop mathematical vocabularies in the local languages have already started.

Conclusion

After years of relying on imported curricula, many PICs are now at the stage of developing the curriculum that they believe best suits them. It is interesting that, in these attempts, many of the countries still use overseas experts. What function these experts play is critical because, if they are in the driving seat, we may soon find ourselves travelling along the same road again. Overseas experts could in fact partner with local counterparts in building bridges between the traditional and conventional perspectives of mathematics. Careful consideration of the construction and nature of the bridges is very important. Ellerton (1997: 121) identified factors for building effective bridges:

Bridges are likely to provide a more effective mode of communication if the architects and engineers who are involved in their design and construction have a sound understanding of the work done by those on both sides of the bridges, and a realisation that the bridges should not only include cultural and philosophical exchanges, but should also enhance the quality of existence of all parties involved.

Where differences arose, Ellerton (1997:121) suggested the need to reflect on respective cultures, to reach out and ‘incorporate a genuine sharing of ideas, marked by lively discussion, joint projects, and democratic partnerships’. Effective bridges will also help us to prioritise the mathematics topics better, given that some ideas are more important to our people than others. For example, the fact that most Pacific cultures are averse to counting and numbers are not used much suggests that the topic Numbers may not be the best one to start with. I am not suggesting that number not be covered, only that it should appear at the best place of learning. What then should come first? Would it be Space (locating), or Geometry of shapes, or Measurement?

If numeracy is about the ability to use mathematical knowledge effectively, I cannot think of a better example that that of the PNG student whose traditional
The basics of learning

knowledge appears to be more useful. I concur with the Australian Association of Mathematics Association’s slogan, *Numeracy = Everyone’s Business*. Curriculum developers and educators have the shared responsibility of finding a balance between a totalising global structure and the needs of Pacific cultural identities. The same values and understandings that are engines of growth, participation and livelihood in our societies have the capacity to serve the same purposes in a globalising world.

**References**


9

Application of indigenous mathematics concepts in the elementary syllabus

Steven Hupigo Tandale

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).
The basics of learning

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>
</tr>
</thead>
<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**


The basics of learning


10
Local/indigenous numeracy
and its place in Pacific Island classrooms

Teburantaake T. Kaei

Introduction
Indigenous numeracy is that which arises out of cultural activities and processes and serves a mathematical purpose. The content of mathematics lessons should be based on children’s cultural experiences, whereby their prior learning in language, their skills and their experiences are respected, built on and extended. If this is done, children find the learning of mathematics in the classroom realistic, meaningful, useful and therefore more enjoyable.

Using examples from the cultures of Kiribati, Papua New Guinea (PNG) and Tuvalu, this chapter seeks to reconceptualise the planning and implementation of indigenous numeracy in Pacific Island countries (PICs) by examining the

1. The members of the group who contributed to the ideas in this paper include Teburantaake T. Kaei (Kiribati), Evotia Tofuola (Tuvalu) and Godfrey Yerua (Papua New Guinea).
philosophies, principles and values that underpin the teaching and learning process. What is the vision for the place of local knowledge in the mathematics classroom? What are the challenges to realising that vision? How would one begin to address these challenges?

**Philosophies**

The philosophies of integral human development (IHD) and Pacific ways are entrenched in the national constitutions and the national development plans for Kiribati, PNG and Tuvalu. The philosophies of IHD and Pacific ways call for an education system that gives value and status to communities to support appropriate community attitudes, knowledge and skills that are relevant to community development and nation building.

The responsibility of the education departments in Kiribati, PNG and Tuvalu is therefore to provide an education that will ensure the development of citizens who are able to value both urban and rural community development activities. The premise is that the people of a country develop a system of beliefs and values appropriate to their individual rights and those of the community in which they live. Additionally, the need for, and participation in, further training to develop the necessary human resources in their communities is recognised and enables these citizens to live useful and productive lives.

**Principles**

The following common principles of Kiribati, PNG and Tuvalu, in relation to the implementation of the philosophies, have been identified and are linked to the indigenous numeracy ideas rooted in cultural activities and processes.

- **Cultural relevance**, which involves traditional customs and values.
- **Bilingual education**, the regular use of two languages (vernacular and English).
- **Multiculturalism**, whereby the cultural activities of different indigenous cultures are shared. The diversity of Pacific cultures is the source of our knowledge, skills and attitudes, and these values will promote literacy and numeracy knowledge that can be shared with the rest of the world.
• **Ethics, morals and values**, which relate to work ethics and human and moral spiritual values.

• **Nation-building** activities which promote national and constitutional rights

• **Sustainability** of ecological, economical, technological and social practices.

• **Catering for diversity** addresses gender and special needs. The cultural mathematics that is proposed must address the needs of girls and boys as well as provide a learning environment which is socially and culturally supportive. Students with special needs must be catered for. For effective learning to take place, children who are gifted should be given the opportunity to advance while those who encounter difficulties should be supported.

• **Lifelong learning**, whereby mathematics/indigenous learning is based on three learning principles:
  - we learn best when we build new learning on what is already known,
  - we learn well when we recognise an immediate use or need for what is to be learned,
  - we use ideas and skills in a coordinated way to solve real life problems.

• **Student-centred learning**, whereby students are actively involved in the teaching and learning process.

• **Thematic teaching and integration**, also known as a theme-based approach, in which one theme is a common thread through the different subject areas.

### Indigenous mathematical ideas, processes, languages and epistemologies

The policy documents of Kiribati, PNG and Tuvalu provide opportunities for indigenous mathematical ideas and epistemologies to be taught at primary school level. This is evident from the teachers’ guides, pupils’ workbooks, syllabi, national curriculum statements and assessment guidelines. Despite this, however, the majority of teachers do not understand what indigenous numeracy is, nor how to include it in the classroom. The lack of confidence amongst those tasked with the teaching of indigenous mathematical ideas occurs for a number of reasons, which are discussed below.

Primary school teachers are tasked with teaching all subjects, yet insufficient training, both pre-service and in-service, is provided for specific subject areas such as mathematics. Current teaching practice is such that, unless it is an examinable
subject, despite policy statements to the contrary, teachers do not include it in the curriculum. This is in part due to the fact that there is still more emphasis on the global than the local, as evidenced by an exam-driven system. This in turn is exacerbated by the lack of research on indigenous numeracy, which culminates in a dearth of training opportunities for teachers. This results in missed opportunities for the production of relevant resources. Furthermore, parents do not understand either the concept or the value of indigenous numeracy in a classroom setting. Similarly, there is little or no community involvement in the teaching or learning process which could provide learning opportunities for indigenous numeracy.

**Vision**

*To build a strong foundation of indigenous mathematics to enable students to use and apply mathematics effectively at school, at work, at home and in the community.*

This vision is premised on the present way of life of PICs which is evolving between local and global beliefs, knowledge, skills and influences, although currently there is more emphasis on the global. Despite this, there is a strong belief in local teaching and learning as a means of constructing a foundation for future successful achievement.

Neither the local nor the global should be undermined but, rather, the best of both should be intermarried. Although it is recognised that global knowledge and skills are dominant in PICs, it should not change the educational principle that vernacular languages and indigenous knowledge are needed for constructive and effective learning.

In order to redress the balance and achieve the vision, several strategies are discussed below, in no particular order of priority.

- *Indigenous numeracy to be taught in the vernacular for the first three years of formal schooling*
  PNG and Kiribati are to some extent implementing this, but Tuvalu still provides workbooks written in English.
An equitable balance of the global and local from the 4th – 6th year of primary education PNG is implementing this. It is known as bridging from the vernacular to English. Kiribati and Tuvalu have still to introduce the change as at present curriculum documents place more emphasis on the global from class 4 to 6.

Ensuring the teaching of indigenous numeracy is implemented and monitored
The curriculum should be structured in such a way that it is clear to both teachers and students what the teaching and learning of indigenous numeracy encompasses. In addition, monitoring and in-service training for teachers should be regular, in order for teachers to maintain their competence and confidence in their teaching practice.

Engaging students in practical activities
Providing students with the opportunity to carry out hands-on, practical, relevant activities would enable them to conceptualise and contextualise indigenous knowledge and skills.

Students learn how to articulate the processes
Teaching students how to solve problems is commendable, but it needs to be accompanied by learning how to articulate what they are doing, why they are doing it and how they did it. Student-to-student exchanges as well as student/teacher, teacher/student questioning or explanation and interaction is an invaluable strategy in the learning process.

Continuous assessment as a learning strategy
Assessment of both theory and practical tasks is a critical component in any teaching and learning situation. Hence, teachers must continually assess their students during the process, as well as on completion of a topic and at the end of term. Continuous assessment provides opportunities for both teacher and student to rectify any misunderstandings of a concept or process during the task, rather than on completion of the task.

Community involvement
Involving parents and the wider community in the development of indigenous numeracy lessons and resources would ensure a sense of ownership. Elders in particular are a valuable resource as they constitute the institutional memory
of indigenous mathematical practices of everyday life. Involving the elders in practical activities could contribute to the bridging of local and global concepts.

**Changes and challenges**

Although a very top-down approach, inclusion of indigenous numeracy in policy documents should at least ensure recognition of the validity of the initiative. However, ensuring that policy is translated into practice is the challenge. Curriculum planners should be compelled to provide support for the formulation of indigenous numeracy syllabi.

Following on from policy, in-depth training at teacher training institutions for new teachers, and in-service provision for practising teachers is required. Indigenous numeracy requires a hands-on approach and practical examples of how to apply the theoretical knowledge. Teachers need the skills to formulate appropriate learning activities. Change is often resisted by teachers as it invariably requires them to shoulder an extra burden. However, if the value of teaching indigenous numeracy (in the vernacular) can be demonstrated to teachers as beneficial to learning, they may be more willing to implement the new policy.

Dissemination of an agreed policy is vital. Those who are responsible for informing the various stakeholders of new directions/dimensions in a policy should ensure that adequate notice of changes to the ‘what’ and ‘how’ is given in order for implementation to be effected. Regular monitoring of actual practice is vital in order to ensure that implementation is indeed occurring.

A review and update of mathematics teacher guides is necessary. At present the teachers’ guides for mathematics do not incorporate sufficient guidance for teachers on how to deliver indigenous mathematics. Even after training it is important that a guide is available for teachers to refer to when they return to the classroom.

Current assessment practices also need to be reviewed. The most common type of assessment is theory-based and summative. Practical assessment, on the other hand, is rarely applied, despite the fact that it is the only way to determine whether
the students can apply the concepts or not. Since indigenous numeracy focuses on relating mathematical concepts to real life situations, practical assessment should be encouraged, not only as a summative process but also as part of a continuous assessment approach.

Although this is contentious, a review of the general teacher policy is necessary. Government policy on teaching at the primary level, whereby teachers are required to teach all subjects, needs to be reconsidered and take into account the range of knowledge and skills teachers have. In order for teachers to be competent and confident in the implementation of any curriculum, they need to be knowledgeable and experienced in the subject content. Therefore, a form of specialisation is proposed that allows primary teachers to teach three subjects at the most.

It is advisable to encourage teachers to develop a culture of learning whereby they themselves initiate professional development. This does not necessarily involve ‘training’. Sharing good practice, exchanging ideas, working collectively to produce resources for activities which can be gathered in teaching banks are all examples of professional development. All too often teachers work in isolation, particularly in remote rural areas, although this also happens in urban schools. Not all development needs to be a top-down initiative and prescribed by either the ministry of education or district officials; informal gatherings can be just as effective in generating ideas which can be included in classroom teaching. However, if the ministry of education were to create school clusters with one school designated as the central contact point in each cluster, this may facilitate better communication between schools as well as between the ministry and schools.

Parental attitudes must also change. Currently, the common perception is that school is the primary vehicle for learning. Involvement of parents and the wider community in teaching and learning is to be encouraged. After all, historically they were the teachers before the introduction of formal schooling. A new ethos of working with schools to provide the best and most appropriate learning opportunities for their children would help cement indigenous numeracy in the curriculum.
Implementing the vision is more than just a paper exercise; it would involve all stakeholders, i.e. the ministry of education and relevant departments, school management, teacher educators, teachers, students and parents.

Some Pacific governments have recognised the importance of indigenous numeracy and it is documented in various policy documents. Where such policies do not exist, they must be developed. However, merely documenting policy is not sufficient, strategies for translating policy into practice must also be formulated. All too often, new initiatives are top-down and imposed on already over-burdened teachers who merely shelve them and carry on as before.

Lack of recognition of the value of indigenous numeracy by parents means that there is no demand for teachers to include it in classroom practice. Similarly, as it is currently not an examinable subject, there is no accountability to the education authority, so at school level there is no compulsion to include indigenous numeracy in teaching.

There is a great need for advocacy on what numeracy is all about, both at the grassroots level and for those in authority. If numeracy is about the ability to understand mathematical knowledge as well as to apply it in real life situations, we need to consider these two questions. What are our priorities? What do we value? The vision To build a strong foundation of indigenous mathematics to enable students to use and apply mathematics effectively at school, at home, at work and in the community is in essence a call for administrators, curriculum planners and teacher educators, teachers and parents to work together in the formulation and implementation of a balanced curriculum, which incorporates the best of local and global numeracy concepts.
A united front for professional development and training in numeracy

John Beuka

Increasingly, education authorities in Pacific Island countries (PICs) are emphasising the teaching of numeracy as a ‘tool’. This shift in thinking is partly due to PICs being swamped with new ideas and technologies that require an increase in numeracy competencies. That, coupled with the acknowledgement that numeracy practices already exist in traditional indigenous technologies, has created a new paradigm.

In this new paradigm, a pedagogy involving integrating and contextualising global numeracy concepts with indigenous knowledge and skills is advocated. This paradigm shift requires a fusion of numeracy concepts from local, Pacific and global societies.

1. The members of the group who contributed ideas for this chapter include John Beuka (Solomon Islands), Chandrika Prasad (Fiji), Ian Kennedy (Vanuatu) and Falasima Kautoke (Tonga).
The basics of learning

The new paradigm implies a transition from the more traditional pedagogy of a teacher-centred mathematics classroom, using metropolitan textbooks for exercises, to that of student-centred learning with hands-on experience in practical mathematics in local settings.

This learner-centered approach anticipates equipping learners with the skills for life-long learning, as well as producing more adaptable and marketable learners for the local, Pacific and global workplace. However, for efficient management and effective implementation and transition to these new ideals, teachers need to have a sense of ownership of them, believe in them and be well versed in any new initiatives. In other words, they must also be active participants in life-long learning. It is therefore of paramount importance that relevant and appropriate professional development and training is given, hence the rationale for this chapter: *A united front for professional development and training in numeracy.*

Introduction

This chapter focuses on definitions of professional development and training. It examines the current policies and frameworks in place for professional development and training of teachers in Fiji, Solomon Islands, Tonga and Vanuatu. It briefly examines current policies and to what extent these are being implemented. It then focuses on the advocated vision for professional development and training, the likely challenges that will be encountered, and suggestions on how to meet these challenges.

What is professional development and training?

‘Teachers have a crucial role to play in preparing young people, not only to face the future with confidence but also to build it with purpose and responsibility’ (Delors, 1996:14).

In order for teachers to fulfill this crucial role they must be equipped with the requisite knowledge, skills and attitudes. It has long been recognised that many teachers in many PICs do not have enough training or even a high enough level of education themselves to be fully prepared to face the demands of teaching
(Lingam, 2004). In 1995 a working group of teacher educators in the Pacific reported that the ideal teacher education curriculum should produce a teacher who:

- has a holistic view – who is concerned for the overall physical, mental, cultural and spiritual development of the child.
- recognizes the cultural underpinnings in the various disciplines and uses these to advantage.
- has a thorough understanding of human development in the Pacific, and of the roles of education in Pacific societies.
- views education as a preparation for life, not merely for employment, so that she/he develops each child’s potential to become a worthy member of society.
- has sufficient flexibility not only to draw on the strengths and inspirations of his/her cultural roots, but who can cope with and educate children of societal and technological changes. (The ability to balance western and traditional cultural values and methodologies would be valuable).
- has the necessary problem-solving and research skills to be a reflective teacher.
- sees himself/herself as a positive role model for the children and the community in which he/she serves.
- has appropriate learning to learn skills to cope with changes in the environment.
- has a thorough and up-to-date knowledge of the school curriculum.
- is able to successfully function in multiple classes or very large, single class contexts.
- will seek ongoing professional development.
- will be able to evaluate both learning and teaching.
- assists in evaluation and revision of the teacher education curriculum.

(Extracts from Benson, 1995:3)

A broad definition of professional development is some programme or activity that develops a person in his/her professional role. This could include formal workshops, courses and mentoring, but it also refers to informal experiences, such as reading publications and journals and an exchange of views and experiences with other practitioners (Villegas-Reimers, 2003).
The basics of learning

The traditional perspective in PICs of professional development and training is often associated with upgrading qualifications for school principals, teachers, ministry of education personnel and curriculum development (CD) officers. Whilst upgrading of qualifications is laudable, and in many instances very necessary, the broader definition of professional development implies a more constructivist approach, rather than the transmission model often applied in the Pacific.

In a paradigm shift that will include contextualising numeracy that involves local indigenous knowledge, this perception of professional development and training must change.

Existing frameworks and policies: the extent of implementation

Some Pacific ministries of education acknowledge the importance of making learning locally relevant as well as keeping up with global trends in education. This is reflected in existing frameworks and policies. Examples are: the Fiji Ministry of Education Strategic Plan 2006 – 2008; the Tonga Education Policy Framework 2004 – 2019; the Vanuatu Five Year Master Plan 2003 – 2007; and the Solomon Islands Education Strategic Plan 2004 – 2006 (second edition).

Incorporated in these policy guidelines are references to:

- school curricula emphasising numeracy as a ‘tool’ and integrating and fusing indigenous ideas with the global;
- professional development and training that focuses on appropriate ongoing quality pre- and in-service training, workshops for practising teachers on the new pedagogy, and awareness programmes for the community to embrace the change and innovation;
- partnerships among stakeholders: teachers, school leaders, ministry of education officers, curriculum development officers, parents, communities, teacher educators, governments and NGOs. In place is a policy on partnership among stakeholders culminating in appointment of advisory committees;
- financial assistance from government budget allocations and aid donor partners.
Although there are existing frameworks and policy guidelines there is little or no implementation in most PICs.

Preparing teachers to implement planned change

In terms of professional development and training, Fiji and Solomon Islands are currently reviewing their programmes to upgrade the qualification of teachers. Fiji is also establishing a Learning Centre solely for professional development and training. The type of training envisaged for the Centre is the provision of short courses and workshops for practising teachers, principals and other stakeholders. Despite these developments, few workshops for practising teachers have been carried out, and planned community awareness programmes did not eventuate in 2005.

In terms of partnership, there is minimal collaboration amongst the different education stakeholders in Fiji, even within the Fiji Ministry of Education departments. This seems to stem from compartmentalisation. The organisational structure, which has witnessed the establishment of departments such as the national examination centre, the schools’ inspectorate, teaching training, and curriculum development departments, all with separate functions, has contributed to this compartmentalisation. Furthermore, this notion of compartmentalisation extends to the wider education system; the provincial education authorities, church education authorities, schools, teacher training institutions and NGOs. The departments and the educational organisations were established so that the different components of the process of equipping the learner with the necessary tools, that is the relevant knowledge and skills, would be shared.

There is insufficient support to effectively implement policies. This is, in part, attributable to the geographic and demographic nature of small Pacific islands. Many PICs do not have adequate natural and human resources to support the undertakings prescribed in the policies. In most PICs the few workshops and ongoing current review of curriculum materials is funded by donor countries. In the case of the NguzuNguzu primary school curriculum project in Solomon Islands, funding is from the European Union.
Vision for professional development and training

‘A united front for professional development and training to be coordinated by the curriculum development unit’ is a vision. It is believed that professional development and training is everyone’s business. The diagram below enshrines an idea that will bring about more relevant and focused professional development and training for a nation.

The vision of quality, relevant professional development and training is to be a collaborative effort of all education stakeholders and it must be focused on the learner. The notion that professional development and training is everybody’s business advocates shared visions, shared ownership and shared financial burden for a common goal—the numerate learner, culminating in a numerate society.

Therefore, inputs of the ‘what’ and the ‘how’ of professional development and training must emanate from all stakeholders. Planned professional development and training programmes with this kind of input will be more focused, making it easier to accomplish the intended objectives. It will be culturally relevant and therefore avoid the ‘one size fits all’ of current practice. This kind of approach
to professional development and training is more suitable for such a culturally diverse region as the Pacific. However, there is no escaping the fact that there are many hurdles to overcome.

**Overcoming the hurdles**

The first challenge is to develop policies that are reflective of and have clear guidelines about areas of responsibility. The policies ought to:

- provide opportunities for better coordination of activities and planning by all stakeholders, sections, and departments within each ministry of education
- establish or strengthen coordination between education authorities, schools, teachers and the local community
- be ethically and culturally democratic
- be relevant, with workable frameworks of action
- formulate workable and appropriate strategies that ensure successful and sustainable fusion
- minimise duplication and contradiction.

The first challenge involves collaboration and cooperation among all education stakeholders in the development of these policies. Better information networking among stakeholders, including many education ministries or departments, will allow for significant dialogue, thereby reducing the existing compartmentalisation syndrome. The difficulty of satisfying all stakeholders will in itself be a challenge.

The second challenge will be to minimise the mismatch between what is being written (policy) and what is being practised. Currently, teachers are often victims of their own learning experiences, that is, teaching activities emulate the traditional ‘chalk and talk’ methodologies of the past. Teachers, as implementers of a more learner-centred, inclusive approach, must understand, accept and embrace this conceptual shift.

A third challenge will be to ensure that the content of professional development and training is relevant to the local context and is owned by the indigenous authority. In small island nations this is often not the case. Some of the problems currently experienced in professional development and training are associated
with foreign ‘experts’. These experts are provided by the funding organisations, so collaboration is minimal. Furthermore, the expert’s ideas become dominant and marginalise any input of the indigenous professionals.

Perhaps the single biggest challenge is the availability of material and human resources necessary to effect change. Two major concerns need to be highlighted: the scarcity of financial resources and the misappropriation of available funds. PICs are small and therefore finance is scarce, despite budget allocations as high as a third of the overall budget for a financial year. Another major concern is the diversion of funds earmarked for education to other sectors. Consequently, the sustainability and continuity of education initiatives, such as professional development and training, are precarious at best.

The way forward—learning from others

The goal of the missionaries was to convert the people of PICs to Christianity. To achieve this vision, the missionaries correctly acknowledged the need to educate the indigenous population, and this included developing and training certain people of status in local societies in basic arithmetic, writing and reading in order to be able to ‘spread the word’. However, the transformation to Christianity required that the vision was shared, accepted, understood, embraced and owned by the indigenous ‘pagan’ and required a joint effort by local chiefs, missionaries and the people working together for a common goal, a Christian society. Agreement on a strategy of inclusiveness for those who are going to be affected by the transition, like that employed by missionaries, is worth adopting in our endeavour to develop agents of change to further the cause of a numerate society.

The first step towards a relevant professional development and training programme that accommodates local and global numeracy ideas is for indigenous chiefs, elders and stakeholders to be well versed with the new idea. They not only need to be well versed, but also to believe in and appreciate the value of the change. This may require some initial training for those people, as well as for influential people in the education system itself. One of the paradoxes of moving towards a vision is that the vision needs to be lived before it can be totally achieved.
The second strategy is to ensure commitment from these change agents. All stakeholders must assess the current position in relation to achieving the vision. Recognition of their position and role with regard to the change will assist in, and bring more focus to, the implementation of policies. Motivational incentives can bring about commitment. This need not be a cash incentive; personal professional development, improved conditions of service and upgrading qualifications can go a long way to securing allegiance.

An equally important step is to have adequate time for consolidation, allowing the stakeholders to become comfortable with the new status quo. Gradual change is often more effective and sustainable. Good monitoring needs to be established in order not to regress to old behaviours. Research is to be cultivated and nurtured in the education system as it is invaluable in analysing and monitoring progress and the effectiveness of the change. The teacher training institutions should be the leaders in research, and their findings used as the basis for professional development and training content.

Finally, financial acumen is to be encouraged to ensure availability of material and human resources when required. Governments often seek assistance from donor agencies for education projects. Best practice is to identify the needs and then design project proposals that incorporate all the resources necessary to complete the undertaking. In-built mechanisms that minimise misappropriation and mismanagement of resources are to be encouraged. The value of good leadership is to be encouraged and recognised in all sectors of the education system.

Conclusion

Professional development and training is an essential component of any organisation. This component embraces change and keeps the organisation abreast of new ideas and technology. However, professional development must be relevant to local needs within the global context. This means that everyone who is going to be affected needs to embrace the vision. Contributions from all stakeholders, of ‘what’ is taught and ‘how’ it is to be taught, are imperative for the shared vision to become a reality.
The basics of learning

References


