Mathematics "Both Ways": a Mathematics Curriculum for Aboriginal Teacher Education Students

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In the Northern Territory of Australia there is an Aboriginal population of some 35,000. Over 80% of these people live in the rural and remote communities of the Territory's 1 35 million square kilometres The provision of appropriate schooling to the people of these communities has been problematic ever since white settlers and missionaries began imposing their presence in numbers early this century The conflict between white school practices and Aboriginal values and traditions, is exemplified by Aboriginal politician Wesley Lanhupuy [1987b], based upon his experience of schooling at Yirrkala[1], and in his own neighbouring community in North East Arnhemland, in this way:

> Schools have been part of the colonisation of Australia and its original inhabitants. Schools were introduced and imposed on Aborigines following the fierce struggles for land between Aborigines and the new white settlers ...This colonisation process has taken place within living memory in the Northern Territory and unfortunately continues in many of our schools today. .. The strong Balanda[2] cultural orientation of the (school) and the dominating power of Balanda teachers and administrators inevitably work to influence the minds of children in ways that undervalue the Aboriginal heritage Aboriginal people now understand that if schools are to serve the political, social and economic purposes of their own people, the school as an institution, needs to be accommodated within Aboriginal culture itself. .. The decolonisation of schools in Aboriginal communities is the challenge for Aborigines now.

The evolution of RATE "Both Ways" teacher education

In Lanhupuy's writing can be found what has come to be the essence of a unique metaphor for what Aboriginal people expect of schooling for their children In its most usual form it is the notion of a "both ways" education, an education that recognises the validity of the knowledge bases from both the Western and Aboriginal traditions. This contrasts with the curriculum of white schools in which the focus is on "one way" Western traditions.

However the term "both ways" itself is now becoming problematic. Helen Watson-Verran [1993, p 3] of Melbourne University reminds us that "What Aboriginal communities want is a unified form of schooling that never relents in its expression of Aboriginal culture. Western knowledge might be coopted for Aboriginal purposes but in being so appropriated it is transformed into Aboriginal knowledge." While she prefers to think now in terms of "commonground" Aboriginal education, the challenge initially was to find the means to decolonise Aboriginal schools and put "Aboriginal ways" squarely on the curriculum agenda along with "Western ways".

An essential ingredient for successfully meeting this challenge was seen to be the employment of Aboriginal teachers trained under appropriate forms of teacher education to work in the community schools.[3] "Aboriginal children need Aboriginal teachers" was a catchcry of the time that retains validity today. At Yirrkala "Dr Maria Brandl worked under the direction and instruction of senior community leaders in 1974 to conduct research into appropriate responses of the Northern Territory Department of Education to the establishment of Homeland Centre communities on traditional grounds.[4] ...Brandl was convinced about the sensibility of the Yolngu[5] request to develop a unique form of teacher education that was community-based at Yirrkala and that was relevant to the needs of the Yolngu in their quest to maintain and retain their Yolngu heritage" [Marika *et al.*, 1989, p.8].

One outcome was the commencement at Yirrkala in 1976 of an onsite program of the Department of Education's Aboriginal Teacher Education Centre (ATEC). ATEC subsequently came to be known as Batchelor College and the onsite program as Remote Area Teacher Education or "RATE" RATE was designed so as to allow students to study the teacher education course at home rather than have to attend classes at Batchelor, a former uranium mining town 100km south of Darwin. The community experience was that "students who go away, grow away" The RATE program with its mixed mode of delivery proved very successful and soon became the preferred mode across all courses of Batchelor College.

RATE has evolved from those early days as a bi-cultural "both ways" model of education. RATE employs teaching strategies such as small group work and team teaching which have been found more appropriate for adult Aboriginal students than Western traditions of course readings and lectures. Likewise RATE pedagogy calls for problem-posing/problem-solving approaches to learning, curriculum negotiation, and integrated curriculum planning supported by appropriate assessment strategies including criterion

referencing, descriptive reporting, and non-competitive assessment It expects that staff and students will engage in action research leading to continuing course evaluation The emphasis on understanding knowledge bases in terms of their cultural origins means that RATE courses are social constructivist in philosophical orientation [see Watson, 1991].

The RATE teacher education course is community-based and community-focused and aims to have a role in developing its students' skills in the defence, maintenance and further development of Aboriginal culture. The acronym RATE is now well known as a symbol for Aboriginal access to tertiary education and Batchelor College courses have been commended in nation-wide forum. For example, Recommendation 294 of the Royal Commission into Aboriginal Deaths in Custody (p1106) states:

> 294 That Governments and Aboriginal Education Consultative Groups take note of the methodology employed in such programs as that at Batchelor College, Northern Territory in the training of Aboriginal teachers and others for work in remote communities [6]

RATE has now come to mean "Remote Area Tertiary Education" with Batchelor College offering courses not just in the field of education studies. Students may now also enrol in such diverse fields as parks and wildlife management, community management, media and journalism, health worker studies, arts and so on. The mixed mode "both ways" approach is now common to all courses and is proving so popular that there are now some 800 students enrolled from over 150 communities in the Northern Territory, Queensland and Western Australia.

Problems in the classroom: a mathematical example

While the evolving RATE program was leading the way in establishing the delivery parameters of a culturally appropriate community-based "both ways" teacher education that would be supportive of the decolonising of Aboriginal schools, there were still problems in the way in which the curriculum content was constituted. This was evident in all "subject" areas, but because of the continuing pressure for "standards" the particular issues of Western mathematics in Aboriginal education was highlighted.

According to Bishop in his provocative article "Western mathematics: the secret weapon of cultural imperialism" [1990, p.51]:

> Of all the school subjects which were imposed on indigenous pupils in the colonial schools, arguably the one which could have been considered the least culturally-loaded was mathematics. ... This article challenges that myth, and places what many now call "western mathematics" in its rightful position ... as one of the most powerful weapons in the imposition of western culture

One outcome of such cultural imposition can be seen in the view of mathematics that teacher education course entrants bring to the Stage One bridging program. As products of colonial schooling they see mathematics as the mastery of school room techniques which have no real-world relevance, and are "owned" by the dominant culture. They have been drilled in their schooling to view mathematics as a doing rather than as a thinking subject. This is problematic for a program that intends to train them as teachers in a social constructivist mould.

Just how entrenched are such conceptions was brought home when I carried out a small study in a community school with potential Batchelor College entrants. I worked with a group of 8 post-primary girls aged between 13 and 19 years. These girls were typical of the students to be found in post-primary sections of community schools across the Northern Territory. They would have been attending primary school from about 7 to about 12 or 13 years of age, but while they may have progressed through the primary grades actual achievement levels at the end of primary are commonly much lower as measured by standardised written tests (but that is another story).

It is Government policy that secondary education is not provided at the community level in the Northern Territory.[7] Instead children wishing to go on to secondary education must go to boarding institutions considerable distances from home, and sometimes interstate. As with teacher education students, it is not uncommon for Aboriginal parents to resist sending their children away from home to study, and especially so the young women. It is also not culturally appropriate for teenage boys and girls to continue in mixed sex classes in the primary school.

The Department of Education attempts to cover such shortcomings by providing post-primary annexes to larger community schools. These usually consist of one male and one female teacher who attempt to devise appropriate teaching programs for the teenage boys and girls of the community. The success of the actual program offered is very dependent on the skills and interest of the teacher appointed, and there are no Aborigines trained for post-primary teaching. While the quality can be very good it is still a far cry from a true secondary education and the post primary section can become simply a place for bored youth to "hang out". Such would have been the background of the post primary girls with whom I was working.

I gave the girls two tasks to do for me. I first asked that they each make up an arithmetic problem that would be hard for their friend to work out. The second task was for them each to make up a difficult mathematics problem for their friend to work out, but that this time the problem should *not use numbers*. After designing the problems I asked each girl to work out the answer for themselves. The results that the girls produced (not real names) are set out in Table 1.

When the girls attempted the first task I had to intervene when it became obvious that all the girls were setting about constructing "work sheets" instead of just one problem as I required. In the second case there was outright confusion within the group and it was obvious that they thought I was playing "some kind of trick" on them in asking for a problem that used no numbers. The girls in fact ignored me and discussed the problem in their own language while I looked on. There was much gesticulation and loud argument as they came to terms with the problem as a group. Eventually one of the girls checked consensus within the group and turned to me, saying: "We draw a picture, eh?"

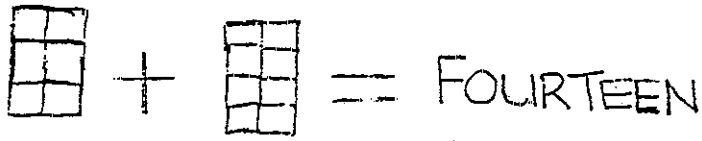
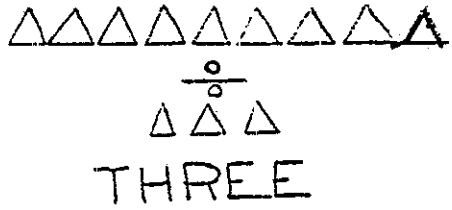
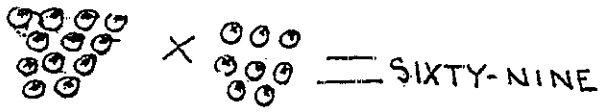
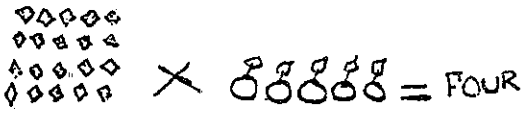
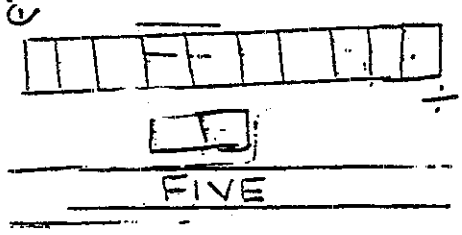
Student	Age	Arithmetic problem	Without numbers
Rachel	16	$8\overline{)906}$ = 12	
Wendy	16	5'4'87 × 2 = 10,974	
Raylene	15	20 × 20 =	
Elaine	13	100 − 800 = 200	
Stephanie	14	$9\overline{)2{,}00}$ = 211	
Fiona	14	100 × 100 = 1000	
Ruthie	15	100 − 9 × = 190	
Gwen	19	5127 × 3 = 15381	

Table 1
Questions compiled by students

From the arithmetic problems designed by the students it is clear that mathematics is seen by them as the doing of algorithms, with multiplication and division being the most difficult. When attention is directed to the "no number" problem it becomes clear just how deeply entrenched is student conceptualisation of mathematics as algorithm doing. As a group, in their own language, they had devised a way to resolve the tensions I had introduced by asking that no numbers be used. They simply changed their signing to disguise their numbering.

In place of digits in setting up the questions, other symbolisation is used such as trees and geometric figures. When I asked that a solution be provided to the problem posed, a second round of negotiation in "language" took place. In the event the solution adopted by all was to provide answers in the form of English language numerals, which obviously are not considered numbers by the students. For these post-primary school students, and possible future entrants to Batchelor College, mathematics is a number worksheet.

Problem with a mathematics curriculum for Aboriginal schools

Consistent with such a characterisation of mathematics, opinion is often expressed that the mathematics curriculum for Aboriginal children should be preparing them in the techniques that they will need in order to take over the key positions within their community and, further, that trainee teachers will therefore need to have "mastery" over these techniques in order that they themselves can teach them "effectively".

But Alan Bishop in *Mathematical enculturation* [1988, p.8] points out that "Business, commerce and industry are too economically controlled to allow for the average employee to experiment with her (sic) "bag of tools" A technique curriculum cannot help understanding, cannot develop meaning, cannot enable the learner to develop a critical stance either inside or outside mathematics. ... a technique curriculum therefore cannot educate ... For the successful child it is at the best training, for the unsuccessful child it is a disaster." [Bishop, 1988, pp. 8-9]

If such comments are pertinent to children of the dominant culture, just how disastrous must it be for the tribal Aboriginal child learning English as a second or third language, and trying to make sense of the "tool box" of techniques being drilled in the mathematics lesson of a "foreign" society. Coming from a culture that does not place high value on quantification of the world compared with the relational, the Aboriginal children are not prepared to question such a casting of Western mathematics. It is little wonder then that teachers and students in community schools come to ritualise lessons through algorithm drill worksheets as a means of coping. Aboriginal teacher education students who have been successful in this ritual expect to be trained to go back and re-enact the same ritual with the next generation of children.

Problems with the teaching of mathematics in Aboriginal schools

Such cultural dissonance is commented upon Beth Graham, in her study of language and mathematics in the Aboriginal classroom as follows:

> ... traditionally oriented Aboriginal children bring with them to school their own particular system of Aboriginal knowledge which has been learned through informal learning-through-living strategies. If these children are to retain their mother tongue and their strong sense of Aboriginal identity, this traditional Aboriginal knowledge needs to be part of their schooling experience. However if these children (or their parents on their behalf) wish to have access to the power inherent in the dominant society they will also need to gain control of the skills and understandings inherent in the M.I. culture.[8] This knowledge, it seems, if it is to empower learners, needs not only to be remembered but should be socially constructed through the use of language about experiences that makes both the mathematical meanings and the underlying purpose of the activity explicit to the learner. [Graham, 1986, pp.17-18]

Pam Harris warns however that the problem is not just with the curriculum in community schools but it is also inherent in mainstream educators attempting to teach mathematics to Aboriginal children:

> If our schools are set up for the express purpose of transmitting the M.I. culture of the dominant group, and our purpose in mathematics lessons is to share mathematical meanings between teacher and pupils, and yet there is a wide difference between teacher and pupils in their understanding of the nature of reality and the way they organise the world to find meaning in it, then the stage is clearly set for conflict and failure. (Harris, 1989, p.91)

In commenting on such a study of mathematics lesson texts through a notion of "curriculum genre", Helen Watson notes that:

> There is a serious mismatch between features of conventional mathematics lessons and the features which would best serve the purposes of learners in Aboriginal schools (autonomous bicultural learners who prefer the oral mode of communication). Experiment and innovation to reduce the degree of mismatch will most effectively be carried out by Aboriginal teachers themselves as members of reflective and experimenting communities [Watson, 1989]

As Lanhupuy has argued:

> In all cases it will be Aboriginal teachers who will be exploring new forms of educational practice. These Aboriginal teachers will develop curriculum and teaching approaches that are uniquely Yolngu, while incorporating those elements of Balanda knowledge and culture needed to function in modern Aboriginal communities and in the broader Australian context. In this sense, a bicultural or "both ways" education for Aboriginal children will emerge" [Lanhupuy, 1987, p.34].

Component	Symbolic	Societal	Cultural
Activities	1. Counting 2. Locating 3. Measuring 4. Designing 5 Playing 6 Explaining Learned through activities in an environment context	1. Current situation 2. Historical issues 3. Contemporary perspectives 4. Future directions Critical awareness of the development of math values in society.	1. Pan-cultural 2. Aboriginal culture 3 Mathematics culture Math as a culture and maths ideas as invention by all cultures.
Values:	**Rationalism/Objectivism**	**Progress/Control**	**Openness/Mystery**

Table 2
Mathematics curriculum organisation map:
freely adapted from Bishop [1988]

In the Northern Territory the majority of these Aboriginal teachers will be graduates of Batchelor College. There is thus an urgency to be creative in seeking new ways in which the mathematics curriculum of Batchelor College can be construed and evaluated; ways which demystify and make mathematics accessible to Aboriginal teacher and child alike; ways which allow the Aboriginal community to co-opt mathematics, its symbolic technology and machines, for their own purposes. The mathematics curriculum of the Batchelor College Teacher Education course is an attempt to travel some way down that path

Mapping the mathematics curriculum

The component activities are addressed over the four stages of the teacher education course of study. The way in which the symbolic activities are allocated over the four stages is set out in Table 3.

Curriculum studies: mathematics organising activities

The most obvious way in which this mathematics curriculum looks different from the "standard" techniques oriented curriculum overview is that it does not consist of a list of techniques, sequenced in terms of an arbitrary hierarchical structure. Instead the techniques may be found subsumed under the notion of six component symbolic "activities" that Bishop proposes are found across all cultures [Bishop, 1988, pp 22-23].

These are set out in Table 2 as counting (how many?), measuring (how much?), locating (where?; when?; who?), designing (what?), playing (how?) and explaining (why?). Not all would agree that these activities are a valid way to look for mathematical commonalities *across* cultures. For example Helen Watson has cautioned that Bishop has been led "... into a serious mistake in identifying the level of abstraction at which one might search for mathematical commonalities across cultures." [Watson, 1989, letter]. Michael Cooke also questions such notions in his study of the relationships between Western mathematics and Arnhemland Aboriginal meaning-making schema, *Seeing Yolngu, seeing mathematics* [Cooke, 1991]. On the other hand these "activity" notions are very helpful in structuring a more culturally sensitive and negotiable mathematics curriculum for adults.

Mathematical activities in the bridging Stage One course

From Table 3 it can be seen that there are two foci in Stage 1 which has a central theme of *Social contexts and mathematics learning*. The first focus is on "What is this thing called mathematics?" which addresses issues to do with the history of mathematics and its socially constructed nature, the nature of recursion, base 10 series, place value and decimals. This extends in the second semester to an examination of the use of mathematics in the community in "How is mathematics used in my community?". This leads students into a study of qualities and their quantification, the historically negotiated origins of common units, measuring tools and estimation. From this it can be seen that many of the key concepts in the development of "number sense" [McIntosh *et al.*, 1992] are dealt with in the Stage One course. Clearly at its most basic level the curriculum covers common bridging course content including technical aspects of number. The innovative nature of the course is found in the manner in which the delivery of the program attempts to meet the needs of the Aboriginal clients

A culturally-sensitive mathematics course delivery

(1) A negotiated mathematics curriculum

The adoption of some form of "activity" focus is essential if the mathematics curriculum is to truly facilitate the implementation of Batchelor College principles to do with negotiation of the curriculum. If the Aboriginal knowledge is to gain true recognition, provision must be made for a sharing of "both ways" in mathematics through negotiation processes that place equal value on both sides. It is difficult to imaging how a techniques-oriented curriculum could be the subject of real negotiation. The "activity" foci suggested by Bishop thus have value in that they allow the learning team (lecturer and student) to stand outside the minutiae of algorithm practice and look at general mathematical principles and the associated values.

STAGE / FOCUS	WORKSHOP ORIENTATIONS	SUGGESTED RESEARCH ORIENTATIONS	SUGGESTED EXTENSIONS & LINKAGES	CONCEPTUAL REFERENCES
FOCUS 1 **What is this thing called mathematics?** **1 SOCIAL CONTEXTS AND MATHEMATICS LEARNING**	Decimal numeration concepts. Counting and base 10 recursion using materials eg counters, Dienes blocks. History of names Number games and play.	Research games Aboriginal children play. What are the rules, how are they negotiated? How is recursion used in Aboriginal meaning schema? Counting.	Computer games-math. focus. Prof-observation of child/small groups. Calculator games. Child art relationships and topology. Language-numeracy.	Counting. Number & numeration Base 10 recursive series. Place value, place holder, zero. Qualities numerosity.
FOCUS 2 **How is mathematics used in my community?**	Measurement. Qualities. Space, time & matter. Historically negotiated names of units. Use of appropriate instruments. Estimation. Arbitrary units.	Research what mathematics is used in community, where, when by whom, why? (instrumental, recreational, aesthetic). Evidence of traditional usage?	Computer simulation software. Calculator strategies. Reporting -tables, charts, graphs.Comstudy-situational analysis.Sc.-density, flotation, body structure.	Comparatives quantifiers. Ordering. Qualities of length, area, volume, mass. Time. Money. Decimal fraction.
FOCUS 3 **What is the relationship between language and mathematics?** **2 LANGUAGE AND MATHEMATICS LEARNING**	Design. Math, language and art. Stretching canvas, colour theory painting, design, sculpting. Analysis of words used in activity. Syntax and sematics.	Research design in community - traditional/contemporary. Identify mathematics located in design (weapons, baskets, canoe, carvings, paintings, icons etc)	Computer art - draw & paint, tesselation, oregami. Logico-grammatical classes of English. Science of materials-physical/chemical change.	Design. Shape. Form. Aesthetic. Properties of shapes. Common geometric shapes, figures and solids. Nets. Tesselation.
FOCUS 4 **How do Aboriginal children make mathematic meaning through speech?**	Locating and mapping using a compass. Orienteering, routing, "mud maps", distance measures. Circles, turning angles, compass construction. LOGO programming.	Research on traditional ways of locating in space, time and society. Kinship systems, age/event correlations, ceremony, oral mapping, metaphor, seasons	Computer-adveniure games. Comstudy- mapping features. Prof.-locating games for young children. Lang.-curriculum genre. Sc-Astronomy/navigation.	Location. Preposition. Route description, compass bearing. Location words. Compass rose, circles, angles, constructions. Mapping. Relationships. Ratio.
FOCUS 5 **How does mathematics make use of symbolism?** **3 SYMBOLS AND MATHEMATICS LEARNING**	Numeration issues. Symbols. Operations with materials and development of algorithms. Numeracy mathematic literacy. 'Mental' calculation strategies.	Research on recursions used in traditional ordering of world/society-kinship naming, ordering, abstraction and classification.	Computer - data base. Comstudy-West. technologies Prof.- Child health issues Sc. Body systems and functions Art 'non-math' symbol design.	Number and numeration. Symbolism encoding meaning. Number patterns. Number relationships. Operations on number. Algorithm. Recursive series.
FOCUS 6 **How do Aboriginal children learn to mean with the symbols of mathematics?**	Explaining mathematical modelling. Classification activities generating data explained in language, symbol and figural modes.	Research on the ways in which Aboriginal children understand maths. The ways in which they use symbols, explain their understanding, make meaning.	Computer graphical representations. Comstudy- math model of community. Sc. - ecology eg food webs. Arts - dance as metaphoric modelling.	Symbolic explanation, classifications, logical connectives. Figural explanation-graph, diagram, chart. Maths modelling. Positive/negative. Fraction.
FOCUS 7 **What mathematics do Aboriginal children need?** **4 LEARNING MATHEMATICS AS A CULTURAL SYSTEM**	Game activity mathematical modelling. Statistical analysis and explanation of data for insights about probability, chance and prediction.	Community research on what children need to know. Review research writings.Philosophical positions. Activity theory.	Computer - spreadsheets. Comstudy community profile. Science survey child health. Arts random assemblies or installations.	Events, probablities, frequency Chance, prediction, tally. Representation of statistics in diagram and graphical form.
FOCUS 8 **How should mathematics learning be sequenced for Aboriginal children?**	Explaining problem solving. Procedures, strategies & plans. Workshop activities that need logicality/conciseness and help 'explain' mathematics itself.	Classroom research on how best to sequence Mathematics learning for Aboriginal children.	Computer planning programs. Language - debate about maths. Science - design a theft alarm. Arts - write and act a play on 'what it means to be three.'	Hypothetical reasoning. Plans, procedures, strategies. Logical argument and proof. Problem solving with mathematics. Value of societal relevance.

Table 3

According to Bishop [1988, p.100], "they are offered as *organising* concepts in the curriculum which provide the knowledge frame. They should be the foci of concern, approached through activities in rich environmental contexts, explored for their mathematical meaning, logic and connectedness, and generalised to other contexts to exemplify and validate their explanatory power". This is the manner in which the foci are used within this curriculum. In each semester unit at least one of the "activities" of Bishop is given focus of attention, so that by the time four years are completed each "activity" will have been addressed at least once.

(2) Research into traditional "activities"

Another of the major benefits of adopting this structure is that it enables what Helen Watson calls the "big picture" of mathematics to be made explicit. The "activities" provide focus issues for community research that have implications in the development of Aboriginal mathematics pedagogy. The use of the "activities" in this way is less problematic than a mainstream approach since students are researching within their own community, in their own languages. They look at, for example, how their people traditionally locate in space, time, and society, and the use of recursion in kinship schema. Whether or not they may come to identify commonground between their own cultural ways of knowing and that of M.T. mathematics will be subject to their own professional judgement.

In support of the notion of such research Bishop [1988, p.41] draws attention to the work of Gerdes [1986] in which examples are given of mathematical ideas inherent in the design work of Mozambican artisans. It is argued strongly that this mathematical work be recognised in their school curriculum so that "By unfreezing this frozen mathematics, by rediscovering hidden mathematics in our Mozambican culture, we show indeed that our people, like every other people, did mathematics" [Gerdes, 1986, p.12]. By providing opportunities for Aboriginal teachers to make similar investigations within their own culture, the stage is set for Aboriginal Australia to identify with, co-opt, and use mathematics.

(3) Calculators and computer

The first key area of world-wide concern identified by Bishop is that of the place of the technology of calculators and computing in mathematics education. This issue has linkages across the curriculum map, intersecting not only the symbolic components but also the societal and cultural. It also calls attention to the notion of conflicting values between the traditional M.T. cultures and asks how a workable and acceptable balance may be negotiated—between progress and control, for example. This technology is highlighted each semester as students are taken through the program, from basic calculator techniques and computer games to the use of spreadsheets and data bases, integrated with other ongoing activity, of course. A critical point here is researching the place of calculators not only as tools for number crunching but also as pedagogical aids in developing number sense.

(4) Language/mathematics interfaces and action research

This curriculum recognises that mathematics lessons are essentially linguistic exercises and that if it is the mathematics of the M.T. culture that is the focus of the lesson then the text of the lesson will be in English, or if not then will depend in some way upon the logico-grammatical schema of that language. For the students of Batchelor College, especially those from the more traditionally oriented communities, English is a second, or even third or fourth language. These students will be working with children learning mathematics at the same time as they are gaining a working command of English as a second language. There are no textbooks that pretend to teach how this may be done. This teacher education mathematics curriculum thus insists that there be a strong *action research base* to the practicum component in which students address the complex issues to do with the interfaces between the English language, Aboriginal languages, and mathematics in the classroom.

(5) The importance of context in learning mathematics

One of the fundamental principles upon which the Batchelor College teacher education program is based is that of integration across the curriculum so as to minimise the unworldly compartmentalization of "subject" studies. This is important in the mathematics curriculum, not just as a theoretical issue, but because mathematical meanings are only made in some cultural context. Beth Graham's [1986] studies have shown the drastic effects on learning when decontextualised activities dominate the mathematics classroom.

Instead, it is expected that in virtually all learning and researching, as appropriate, the mathematics involved will be made explicit and its power as an intellectual tool and a way of knowing will be explored. In this way not only will mathematics be addressed in context, but facility with techniques and procedures will be treated formally on what might be termed "a need to know" basis. In other words students will learn techniques and procedures as they identify for themselves a need to master a particular problem. This might arise in the context of a workshop, or simply be the outcome of a student recognising that a mathematical technique needs to be better understood and rehearsed so it can be taught effectively in the classroom. This is where strong tutorial support must be available with access to expertise and other resources.

(6) A workshop-driven approach to curriculum

While the above makes good sense for adult learners, all is not left to chance. Throughout the program techniques, procedures, and concepts are identified for specific treatment as subsumed under the "activity" foci of Bishop [1988], and the program is cast into a series of workshops rather than in terms of timetabled classes. In these workshops students come together regionally or in larger stage groups, to address common core issues. These workshops are key points in the program and serve not only to share content but also to identify problem areas to be examined

and to establish tasks to be completed in the home community. One outcome of each workshop is community research, the outcomes of which must be presented at the next workshop. In this way the mathematics curriculum is linked to community development concerns as well as professional practice issues so that students come to feel ownership of the program

Conclusion

The curriculum described above is now being implemented across the four stages of the Diploma of Teaching course It has been presented three times in the Stage One bridging program with considerable success. One lecturer in a field report commented as follows on the outcomes of a trial mathematics workshop:

> This workshop indicated to me how important it is to expose the western mathematics system ... the students saw as if for the first time, that their own mathematical system was as complicated, "as hard" and as important as the western system but that both served different purposes. [Moses 1990]

Recently however it has become clear through the ongoing action research process that there are problem areas emerging that need to be addressed if the gains made are to be maintained It is becoming apparent that the bridging course components for the development of tertiary study skills in language and mathematics are being swamped by increasing attention being paid to the professional aspects of teaching that were designed to provide context rather than content. A number of cases have arisen where academic staff have suggested that students have met the course content requirements of Stage One but still do not have the mathematics and language skills to go on.

While this may signal staff professional development needs in the area of curriculum interpretation, it is also true that the outcome is reflecting the enormous pressures that staff experience in trying to produce significant numbers of Aboriginal teachers under very complex and difficult circumstances. However, regardless of the complexities of the problems to be addressed there is a general feeling amongst both staff and students that, far from being dull and intimidating, the study of mathematics in its cross cultural manifestations is both exciting and rewarding. Perhaps such an approach should be tried more widely?

Acknowledgement

I would like to acknowledge the considerable effort and imagination of many past and present members of staff and students of Batchelor College and members of the Action Group of Yirrkala School and their co-researchers and leaders without whose foresight and commitment there would not have been a teacher education curriculum in mathematics for Aboriginal purposes at Batchelor College worth writing about My role has been that of participant documenter of the curriculum development process and its outcomes. The curriculum presented here is truly the outcome of a team effort over many years and an enterprise that by its very nature will necessarily continue to evolve into the future

Notes

[1] Yirrkala is a community established as a mission by the Rev Wilbur Chaseling in 1935 when the missionaries first arrived Yirrkala is on the North Eastern coast of Arnhemland about 600 kilometres East of Darwin in the Northern Territory of Australia.

[2] "Balanda" is the local Aboriginal language (Yolngu Matha) word describing non-Aboriginal people It is derived from the word "Hollander" through trading contacts with Maccassan traders who visited the North coast of Australia annually for some centuries before White occupation of the country. These visits were stopped by the Australian Government early this century

[3] See Mununggurr, D , Yunupingu, B. and Wunungmurra, W. [1987] *Education needs of the Homeland Centres of the Laynhapuy Region, North East Arnhem Land: a report of the Balanga Project* Laynhapuy Council, Yirrkala, NT.

[4] See Brandl, M M. [1974] *Report on Homeland Centres Education: visits to outstations in the Yirrkala area 4-22 June 1974* NT Department of Education, Darwin, NT.

[5] "Yolngu" translates as "the Aboriginal people" of North East Arnhemland in the Northern Territory of Australia

[6] *Aboriginal deaths in custody: response by Governments to the Royal Commission* 1992 Government Printer, Canberra

[7] See White, L. (1992)

[8] "M.I culture" is short for Mathematico-Technological culture and has been used by a number of writers to refer to the culture underlying the "mathematically inspired progress through technology and science" characterised by the so-called developed countries [see Bishop, 1990, p 58]

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In political discussion it often happens that not so much the facts themselves, the contents of arguments, are the issues in disagreement, but rather the structural role they play, the function they have in the context, with all the features of 'because", "but", "nevertheless", 'although", and so forth. Men are unhappy if the complication of such features befogs the issue; they long for a structurally clear view in which the items find their clear place, function and role, do not disturb the main lines and their resulting direction of view and action. This may lead them astray. But one often sees, too, how this tendency to structural simplicity is deeply connected with the thirst to get at the true structure. Experiences and experiments show this strongly and clearly in spite of forces which try to maintain an existing structural view

Max Wertheimer
