Building Bridges Between Aboriginal and Western Mathematics

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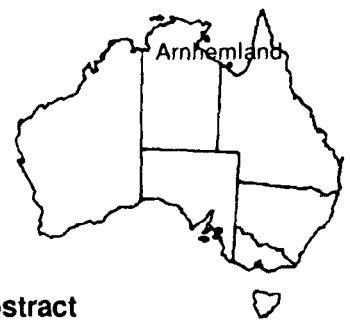

Abstract

The focus of this paper is on how teachers can recognise and build on the mathematical knowledge Aboriginal students utilise outside the classroom. It also examines the importance of providing experiences and strategies in which students gain meaning and develop the appropriate language that enables them to extend their skills in Western mathematics.

> I'm a hands-on teacher and the kids really enjoy all that practical stuff but they can't explain what they've done! There's no way they can work the same thing from written sums or directions I give them.

These sentiments are frequently heard by those who visit predominantly Aboriginal schools where many enthusiastic teachers are at a loss to know how to proceed in the teaching of mathematics. Unfortunately this area of the curriculum is one in which it is easy to keep students busy and, as a result, the students can spend an enormous amount of time 'doing maths' and thereby achieve lots of ticks while gaining very little understanding of how to relate 'classroom mathematics' to the mathematics they already use in everyday life.

There is an obvious need for Aboriginal students to build bridges from what they already know and use if they are to further extend their mathematical competencies. But why do these students underachieve in classroom mathematics? Is this type of mathematics so different from what they use in everyday life? Are the mathematical concepts too hard? Or are there other reasons?

There is evidence that much of the problem can be attributed to the atmosphere and attitudes that prevail in the majority of mathematical classrooms described by Barnes and Webber (1988) as:

> typified by the presence of a teacher who is the source of both academic and disciplinary authority, who dominates classroom talk, who emphasises speed and accuracy and getting the right answer by approved methods, who gives children little responsibility for their own learning and who teaches rigidly with a preference for rule memorisation and the use of a textbook (in Brinkworth, 1994: 2).

The opening remark has in fact identified another major problem that many students experience in the expression 'they just can't explain'. In

mathematics, as in any area of study, students need to acquire a high level of language and communicative competency if they are to succeed in formal education. By this I mean not only the ability to speak Standard Australian English (SAE) in appropriate situations but also the need to gain a clear understanding of its meaning as well as the protocol and associated patterns of social behaviour the language carries. Acquiring English as a second language (ESL) requires learning in depth about English culture and, most importantly, acceptable strategies for coping in difficult cross-cultural situations. To lack these skills can be disempowering as can be seen in the following anecdote:

> In the late seventies a mother mentioned to a teacher that after school she was going to take her children to town to do some shopping. At this point the teacher mentioned that she too needed to shop for food and would also be going to town. Much later in the conversation, and just as she was leaving, the mother asked the teacher if she would buy four cans of soft drink for her children and went to give the teacher the money. The teacher reacted negatively to this request and questioned why the mother couldn't get them herself. The mother made it quite clear that if the teacher bought them they would cost 45¢ each but, if she bought them they would be 50¢ each!

Recording the language many Aboriginal students use when solving problems or working their way through 'hands-on' experiences reveals answers to teachers' questions or comments which are generally restricted to one word or a brief comment. This level of response alludes to an ability to adequately explain and/or record their experiences.

These responses also reflect the diversity of language backgrounds from which the majority of Aboriginal students come. SAE is generally their second language and very often the words they use convey different images to those of the teacher and mainstream society as seen in the following description of the stars depicted on the Australian flag:

> When you laying down in the night
> look at star.
> I was laying down ...
> I look star ...
> It make me remember when I was young.
> When young I think that star really river ...
> river and creek.
> You call it Southern Cross,
> that other star.
> We say it spear and crocodile.
> So, I just look.
> (Neidjie in Watson 1985: 54)

Teachers may argue that most, or at least many, Aboriginal students in the nineties do not relate to this apparently simplistic example. However, confusion over what they hear with words such as ship/sheep, chalk/joke, full/fool cannot be denied, as can be seen in this amusing anecdote. Vic Hunter, a bi-dialectical Aboriginal speaker who at the time was living in Derby, was giving this account of a court hearing which concluded:

> ... that judge bin tell-im then:
> 'Well I fin' you five dollars.'
> She bin tell the judge:
> 'Oh, thank you judge
> because I bin lose that money last week.'
> (in Eagleson *et al.*, 1982: 237)

It is increasingly clear that teaching outside a meaningful context denies students points of reference from which they can gain the meaning intended by the teacher. In the past teachers in the bilingual situation concentrated on semantic differences in words such a 'long' and 'tall' because they are generally represented in

Aboriginal languages by one word, e.g. in *Nyangumarta* these two terms are represented by the term *'makanu'* resulting in a person of reasonable height being referred to as 'long man'. However, while this is important, teachers need to be aware of problems that are more subtly embedded as in the following example:

> Last night the flood water rose ***by*** 5 metres.
> Last night the flood water rose ***from*** 5 metres.
> Last night the flood water rose ***to*** 5 metres.

From this can be seen the need for student involvement and discussion in a number of activities prior to any 'sums' or problems being recorded by individual students. This allows for the subtleties of the targeted language to be utilised and practiced in a total context and for further exploration and clarification of meaning to occur through negotiated texts and other forms of group based recordings. Displaying these recordings provides a maths environment to which students can refer.

There can also be difficulties encountered by students applying rules at inappropriate times. An Aboriginal adult studying mathematics was asked this question:

> Which of these numbers is less than 50? Circle your answer.
>
> 63 81 97 35 52 74

Without hesitation the student circled 35. Then, looking worried and displaying some reluctance, the student circled 52. Following the test the supervisor asked the reasoning behind the way this question had been answered and it was shown that the student knew that there was only one number less than 50 but that the 's' on the word 'numbers' indicated it was plural, therefore it must be a trick question!

There is also the assumption that Aboriginal students make the connections from a particular given task to its place in a total meaningful and useful context. The teaching of schoolroom mathematics in most instances is made up of modules or bricks that are intended to eventually link into a meaningful bank of mathematical knowledge. However, if the bank of Western mathematical knowledge is devoid of a related bank of general knowledge about English culture, teachers find that Aboriginal students are generally unable to access such fragmented knowledge.

When tackling mathematical problems how often do teachers of Aboriginal students get asked, 'Add 'em up? Take 'em away?' The majority of students have a firm understanding that the numbers they pluck from any written sum need to be manipulated and they are usually aware that there are the four processes of addition, subtraction, multiplication and division to choose from. However, the inability to discern which process is appropriate in particular circumstances makes this knowledge inaccessible. It is like knowing that there is something you need in the filing cabinet without having the key to open it. Similarly, in more complex questions where the ordering of the processes need to be prioritised, non-SAE students are even more hampered by the quantity and form of information they are given.

So what can we do to provide a meaningful context while assisting students in the areas of developing language competency and the skills of recording and interpreting?

Aboriginal students need to become aware of how and where they and their families use mathematics. This in itself can be quite revealing and provide a shared experience for them and

their teacher as they investigate and record their findings. They will very quickly become aware of how mathematics is embedded in their everyday lives. In addition, an awareness of how mathematical concepts are expressed and utilised in their own community provides a framework against which they can reflect on the use of mathematics in mainstream society.

The following example is of a time segment embedded in a *Ngardi* story of a man who, following the traditional interchange, takes his new wife from her mother's camp:

Ngurrpa-rla-pula yani-ii, ngurrpa-wayi-pula.
A long way at the two went a long way very the two.

Jinka wali-pula ma-ninja-ya-ni. Yutarnu marda.
A baby then the two brought back. Sitting perhaps.
(Napaljarri and Cataldi, 1992: 3)

Literally translated the story states there has been a time lapse of approximately 15-18 months:

> The two went a long way, a very long way. The two brought back a baby. Sitting perhaps.

Another example of a time sequence can be seen in the *Nyangumarta* terms used for the five seasons of the year and the prevailing factors that identify each one. In a similar way significant times within any twenty-four hour period might be labelled by the names given to the movement of the sun and the moon. However, a comparison with the different concept of time utilising more exact time units and the factors that make this necessary in Western mathematics, expands the teaching of time into a much more fascinating and relevant topic than 'learning to tell the time' in many classrooms. Many teachers coming to an Aboriginal school often express amazement at how the previous teacher apparently neglected to teach the time without realising these skills are only retained and evident where the students acquire and continue to use this knowledge in meaningful contexts.

Different ways of expressing and recording ideas are illustrated by Watson (1989) in *Singing the Land, Signing the Land* where she compares the Western number patterning with the genealogical patterning of the North East Arnhemland Aborigines. In recording examples of the different and similar orderliness this knowledge brings to each cultural group, Watson (1989: 41) concludes:

> With mutual recognition that each side has constructed a system of valuing which is rigorous and rational, and mutual acceptance that each system has particular advantages, we can get somewhere.

While not all Aboriginal students have access to traditional languages to elicit such examples, other opportunities to examine mathematics in practice will emerge in card games, Social Security forms and payments, taxis, banks, the processes of pooling money to buy a car, purchasing food, etc. Discovering mathematics in the students' own community (ethnomathematics) establishes a number of starting points.

It provides the teacher with:

- an opportunity to be a group participant in a shared experience
- the mathematical knowledge base from which the students operate
- real life situations from which to extend a meaningful mathematics program for the students, e.g. a larger picture of the monetary system.
- an opportunity to observe the co-operative/ collaborative approach adopted by the students

- an opportunity to observe the students' use of language, the nature of their communication with each other and the community.

It also provides the students with:

- a conscious awareness of how mathematics is used in their community, i.e. mathematics in a total and meaningful context
- a shared experience on which to base meaningful discussion thus developing mathematical language with peers and the teacher
- joint responsibility for set tasks in which there is a freedom to explore and proceed
- feedback from peers and teacher
- the teacher's acknowledgment and acceptance of 'diverse social interests and practices' (Adler, 1991: 163).

Let's look at each of these points in greater detail.

The opportunity for the teacher to be a group participant in a shared experience enables the role of the teacher to be de-centred. It provides opportunities for the teacher to get to know students and their community on their own terms and preferably on their own ground as opposed to within the structure of the school situation. It enables not only the sharing of giving, but also the sharing of learning knowledge, two crucial elements in the building of relationships through which a meaningful exchange might take place. This reciprocal-interactional approach enables teachers to assist students 'to negotiate and construct their own knowledge, understandings and language rather than simply transmitting such information to them' (Graham, 1986: 19).

Being aware of the mathematical knowledge base from which the students operate enables teachers to develop programs that take the students from the 'known to the unknown', a well accepted principle applied by teachers across the curriculum. It also provides an opportunity for teachers to recognise the 'relationship between mathematics and social conditions and values' (Brinkworth, 1994: 1).

Recently, during a workshop to explore strategies for the more effective teaching of mathematics, reservations were expressed about teaching terms such as 'radius'. The reason given was based on the number of times such terms are encountered outside the classroom. For too long certain words have been avoided in the curriculum for Aboriginal students because they are 'too hard'! If we consider what constitutes a difficult word we find that the only words that are difficult are those for which we do not know the meaning! Teachers need to be aware of the potential they have for disempowering students by making limiting decisions of this nature.

The collection of data allows the teacher to learn from the students and the community and provides opportunities to model language as brief comments are accepted and expanded upon. Students are encouraged to record in a variety of forms — sketches, tapes, photographs, charts, etc. and the teacher may negotiate story texts to reflect the findings, resisting initially the use of abstract representations (sums). These can be used alongside written texts when exploring abstract, 'short cut' ways of expressing these ideas at a later date and can be an integral part of the displayed examples to which students can refer when contemplating future problem solving. This enables students to realise that sums do not exist in isolation but rather they are an abstract representation of a story or event.

A shared experience places the teacher in a position to observe the manner in which students organise

themselves into groups, their interests and abilities as well as how they perceive appropriate ways of recording. It will also reveal the co-operative/ collaborative approach adopted by the students, their home language, the use of silence, waiting and other patterns of behaviour and responses teachers encounter in the classroom.

Teachers through shared experiences are also able to assist students to develop perseverance and independence as they 'strive to develop effective and efficient processes of problem-solving' (Baker *et al.*, 1990: 8). However, the decision to explore mathematics as used in the community needs to be handled sensitively. For example, who decides how, when and where the community is to be examined?

At Yirrkala a program based on exploring the nature of mathematics in the community operates in the school where they refer to their curriculum as Garma Maths, i.e. information open to everyone. Originally called Ganma Maths this term is used as a metaphor to describe the meeting of Aboriginal and non-Aboriginal mathematical ideas as the expression Ganma is derived from:

> the mixing of two streams which flow - one from the land, the other from the sea ... [whereby] the forces of the streams combine and lead to deeper understanding and truth (Watson, 1989: 5).

Each focal activity in the school, orchestrated by the Aboriginal teachers, educational workers, auxiliary staff and community members, begins with the traditional gathering of information in preparation for their working/negotiating through problems and issues in search of solutions in keeping with their understanding of their being and knowledge. The point between these two processes is referred to as Galtha, which:

> represents the initiation of any sort of Yolngu[1] ceremonial activity which has been thoroughly negotiated, with all the relevant contributors. Any Yolngu ceremony begins with 'placing down' of a Galtha, (for example digging a spear into the ground) to mark the end of negotiation, defining and declaring that there is agreement on how to proceed (Yirrkala Community School Report, 1990: 12).

At this point the school becomes totally focussed on the particular experience 'which continually links the mathematical experiences of Yolngu children (through things like the Yolngu kinship system, and patterns of traditional agreements between clans) with the Balanda[2] mathematical world.

Permission for these terms to be used in the school indicates the importance Yolngu place on having their knowledge as part of the school program and indicates the control they wish to maintain over their knowledge. It also indicates the importance they place on transferring that knowledge for use in the school; it is not something to be viewed lightly or to be regarded as 'interesting' but of little value.

While the community at Yirrkala is well known for utilising and promoting this approach it is possible elsewhere for students to initiate mathematical research in their own community. Aboriginal teachers, education workers, community members/parents or other family members interested in the school can be encouraged to contribute and/or make the initial contact with the wider community. The first

[1] Yolngu is a term the indigenous people of North East Arnhemland use to refer to themselves.

[2] Term used by Yolngu to describe non-Aboriginal people.

experience may be small but with positive feedback to the community interest can be fostered to encourage greater community participation and direction to the mathematical program. Feedback could take the form of reports by students to ASSPA meetings, invitations to displays of the students' findings outside the store or in the school, etc.

It is then important to discuss and identify with the community/parents and students where they see a need to build on the areas of mathematics they already use. To implement this it may be necessary for the school to 'hand over' particular projects to the students to work through as a group. It may be possible to provide students with a budget for a forthcoming excursion and involve them in the planning, budgeting, quotes, bookings, negotiating, bookkeeping, spreadsheets, reporting, etc. The skills required would be broader than generally regarded as mathematics but would provide a meaningful exercise across the curriculum. 'Lessons' would focus on practice in the areas in which students realised they needed greater competency.

To develop collaborative problem solving also enables a rich source of exchange as students in small groups co-operatively argue back and forth, posing possible interpretations, solutions and directions. The safety of this interaction in terms of a group identity, as opposed to an individual identity, is appreciated by Aboriginal students who are less reluctant to participate within this more familiar framework. Group authorisation of information removes the 'shame' students may experience if they have not had the opportunity to collaboratively arrive at an acceptable explanation. Students should also be encouraged to record their findings and to use this information to explain their results to another group who in turn have an opportunity to evaluate and comment upon their findings as they interpret the recorded data.

Other shared experiences with an emphasis on mathematics might focus on students bookkeeping for the canteen or ASSPA funds, the paper work necessary for establishing a mine or other industries appropriate to the locality. Following a very successful Sports Carnival attended by a number of Western Australian Aboriginal Independent Schools at Karalundi this year, students at the Rawa Community School near the Canning Stock Route are planning to focus a portion of their mathematical program on preparation for next year's event. It is planned that students of all ages will prepare running tracks, read and record their own times, pulse rates, measure heights they can jump and possibly run a mini Sports Carnival.

Students ranging in age from eight to sixteen years of age at Ramingining in North East Arnhemland several years ago further developed their skills through the setting up of an art/craft exhibition in Darwin. Students provided profiles on each of the contributors, created baskets for sale and organised a display explaining how they were made. They also prepared and practised answers for the types of questions they might be asked at the exhibition by tourists, etc. They extended their mathematical skills in accounting, bookkeeping, planning time frames, booking fares, budgeting and fund raising, etc. while greatly extending their communication skills in SAE.

These real life situations were ambitious with teachers demonstrating positive attitudes. Their high expectations of the students and their ability to become team members provided the students with opportunities to work from the planning, organising stage through to an actual event. It was also recognised that students need opportunities to evaluate and report on their

experiences. Similarly, student research into where their newly acquired skills might be utilised in the wider community may involve a visit to a factory, a bank, a Shire meeting or other organisations as an extension of their studies into broader contexts.

While these examples would traditionally be interpreted as suitable for older students it is vital that this approach is introduced from the time Aboriginal children enter school for, as Bubb warns (undated: 4), as a result of study of the students' mathematics skills at Bathurst Island:

> unless teachers are careful, Aboriginal children can perform at Stage One and Two levels by relying on skills they learnt by rote. The children recognise the combinations and patterns, however, they had no concept that the symbols on paper could represent real-life situations.

The focus on a particular event is also central to Concentrated Language Encounters (CLE) an interacting approach to language learning through modelling and sharing ideas with students as they negotiate meaning. This is in contrast to the teacher/pupil question/answer approach and results in students gaining skills and confidence as they practise 'creative' language in repetitive situations. CLE has the potential to overcome semantic confusion such as experienced by speakers of Aboriginal English as they develop their level of performance.

Including situational plays that explore the roles of participants such as when 'Visiting the Pet Shop' provides students with understandings enabling them to anticipate and respond more effectively as they interpret situations. In this particular example young students at Traeger Park discovered and practised the skills required for issuing receipts, including the need to write amounts of money in words and numerals, recording telephone numbers, taking orders, looking up the calendar to give dates for delivery, giving change, etc. The teachers' participation as a group member enabled the modelling of language and an opportunity to suggest lines of investigation the children might pursue, thereby extending their experience and language while maintaining their interest (Gray, 1983; Price, personal communication)

For many Aboriginal students, the development of links between appropriate images and mathematical language used daily by mainstream society, as seen in the following examples, would form an important span of a bridge into Western mathematical thinking:

a) 'We travelled about 200 km to get here today but we managed it in about two hours.' (linear reference)
b) 'Gravel for the driveway? How much, 1 metre, 5 metres?' (quantitative)
c) 'Our neighbour is thinking of selling off the back half of his ten acres. He expects to get about $5,000. It's quite narrow really, only about 250 metres across.' (spatial)
d) 'I should only be about ten minutes.' (Everyday life divided up and minutely accounted for.)

This brings us to another possible solution in this problem area. If mathematics is part of everyday speech, consideration should be given to extending the boundaries that isolate mathematics to a certain time on the timetable each day. Examples include setting the clock on overall classroom procedures to provide mathematical practice in a meaningful context, measuring fluids in Science and Health, measuring pulse rates and high jumps in Physical Education, exploring comparative language in English, weighing and comparing in Nature Study,

planning a term time line, looking at how the roll call can be represented as a 'sum', etc. These and similar activities make students maths conscious and the acquisition of appropriate language a more natural occurrence.

Shared experiences provide opportunities for students of all ages to absorb new vocabulary in a meaningful and natural manner for use in formal education and mainstream interaction. However, students need encouragement in valuing their home language as they become aware of the roles different forms of language have and when each is appropriate.

Students should also be encouraged to set goals regarding what mathematics they are going to know at the end of a set period whether it be a day, a week, or longer. Students should consistently be encouraged to set realistic goals, making adjustments when necessary but not abandoning positive steps no matter how small. They must also be given time and encouragement to achieve them. In this way they also develop an awareness of their responsibility for their own learning.

Developing a meaningful store of knowledge by assisting students to organise and record the researched ethnomathematics for the community on computer programs such as Hypercard utilising scanned photographs, video clips, recorded stories, etc. is no longer unrealistic. This bank of information will provide the impetus for further interest and involvement of the community and do much to raise the self-esteem and pride of those involved. The recordings, of course, need not be restricted to the ethnomathematics of the community but could also provide a pylon for yet another span of the bridge into Western mathematics.

Aboriginal students need opportunities to develop positive attitudes to mathematical learning. Grundy (1994), when debating the development of the National Curriculum Statements and Profiles, made this comment to teachers:

> The emphasis upon the recognition of what students can do rather than what they can't is worth struggling for as a positive affirmation of learning. The outcome statements allow teachers the opportunity to provide an account of success rather than of failure (Grundy, 1994: 6).

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