Mathematical Registers in Aboriginal Languages

TAMSIN ROBERTS

'Give me five dollars!'
'Could you lend me five dollars?'
'Oh, um, look, I've left my wallet at home and I need to catch the train, do you think you could lend me some money?'

These are three different ways of requesting money. Although all are grammatically correct, their success would depend not just on how well the information was conveyed, but also how each request respects the relationships among the speaker, the listener and the circumstances. In any language, there are many ways of saying or writing the same thing. However, the one chosen is the one that 'sounds right': that is, it is the one which, in a given situation, best matches the purpose of the communication to the audience, whether listener or reader

As Aboriginal adults find it necessary to discuss Western mathematics, and choose to do so in their own languages, mathematical registers will develop in these languages. Such registers will have distinct vocabulary and particular grammatical structures in the same way that the mathematical register in English does When communities make choices about aspects of mathematical registers for their languages, they will be making similar choices to those which all speakers or writers make in deciding how best to express themselves. However, because mathematical registers are a new development in Aboriginal languages, there are presently no expressions which 'sound right', but rather only different potential ways in which to express the information. If communities make explicit decisions about how they want to express themselves mathematically, these decisions will determine those expressions which will come to 'sound right'.

I work as a teacher-linguist in a bilingual school on a remote community in the Northern Territory of Australia, but am a non-Aboriginal person who belongs to mainstream Western culture A teacher-linguist helps to develop Aboriginal language programmes by providing information about teaching and linguistics, while Aboriginal people provide information about their language and culture. Many of the Aboriginal teachers with whom I work are untrained, so there is a need to combine their knowledge of their language and culture with my knowledge about teaching language programmes. These programmes are then taught by Aboriginal teachers.

My role as a teacher-linguist is to make available as much information as possible, so that Aboriginal communities with whom I work can make informed decisions about how they want to develop mathematical registers in their own languages. In this article, I outline some of that information: the choices which could be made; and the possible consequences for the languages in making those choices. This is a starting point for discussion and the choices examined should in no way be seen as the only options. Aboriginal people will evaluate this information and will change their languages in ways which are appropriate to their communities and situations.

The need for mathematical registers in Aboriginal languages

There are about ninety distinct Aboriginal languages still spoken in Australia (Gale, 1994, p. 33). The number of speakers and the strength of the languages vary considerably. Pitjantjatjara has several thousand speakers and is spoken over an area which covers most of South Australia, part of Western Australia, and part of the Northern Territory. Ndjébbana, on the other hand, is spoken by the Kunibidji people of central Arnhemland, on the north coast of the Northern Territory. There are between 150 and 200 speakers in total, almost all of whom live in the township of Maningrida

Aboriginal languages have always been able to discuss Aboriginal mathematical ideas and there is appropriate vocabulary and specific grammatical structures to do this. However, Aboriginal cultures did not use mathematics in a Western way: that is to say, they did not quantify, specify relationships, locate themselves or use shapes for designs in the same way that Europeans traditionally have. With the growing influence of Western culture on community life, choices are having to be made about the language used to discuss Western mathematics.

Most adults in remote Aboriginal communities learnt Western mathematics through the medium of English. Ever since the introduction of bilingual education into Northern Territory schools in 1973, mathematics has continued to be taught in English. In discussions about the separation of domains in bilingual schools, mathematics has usually been considered so firmly entrenched in the Western domain – that English needs to be used to teach it (Harris, 1985). As a result, non-Aboriginal educators have often said that children should wait to learn maths until they have sufficient English through which to learn it.

However, the mathematics (Western or traditional) that is actually used in communities is not generally discussed in English Council meetings, where for example decisions are made about applying for grants or where budgets are discussed, are almost always held in the community language,

For the Learning of Mathematics 18, 1 (February, 1998)
FLM Publishing Association, Kingston, Ontario, Canada

although brief explanations may be given in English to non-Aboriginal advisers or government officials.

A few years ago, in a community where I was then working, I overheard a discussion in the local language, Pitjantjatjara. The football team was to go to Alice Springs to play a competition game. The truck, which was to take them, needed enough fuel so that it could get there and back again. The problem discussed by many members of the community involved which people should contribute money for the diesel and how much each of those people should pay. It was decided that only the football team should pay (and not all members of the community which had been suggested) and the amount that each of the team members had to contribute was calculated. Someone was organised to stand in the store and collect the money as the team members cashed their cheques.

At no time during the discussion did people stop and say 'our language can't discuss this maths problem, we should change and talk in English'. Aboriginal teachers are also graduating and teaching in community schools in increasing numbers. These teachers are teaching mathematics and discussing it with their students in their own languages as well as in English. They feel that it is important that students are taught concepts in their first language, for, as they themselves found when they were at school, it can be very difficult to learn mathematics through a language in which the learners are not fluent.

Mathematical register choices

English has developed a mathematical register over several centuries - see Halliday and Martin's (1993) description of the emergence of 'Scientific English', as well as Halliday's (1978) account of the mathematical register in English. Aboriginal languages do not have such a luxury. Without overt and conscious decision-making about how mathematical registers are to develop, Aboriginal languages could develop mathematical registers which have the grammatical constructions of English. This in itself is not problematic if that is what the community decides will happen.

In many classrooms, this appropriation of English grammatical structures is already happening, as Aboriginal teachers in the act of teaching try to express a mathematical concept in their own language and find that an English term or expression is the easiest way in which to do it. This code-mixing could have long-term ramifications on changes to the whole language (Harris, 1990, p. 93). By using new grammatical structures or increasing the importance of structures which were rarely used, traditional grammatical structures could be lost, resulting in communities being unable to talk about some traditional knowledge in the same way as previously. [1]

To make decisions about mathematical registers, Aboriginal people need to know what a mathematical register is, what its essential features are and what features can be omitted or changed. They also need to talk about how their own languages operate, so that they can make more informed decisions about changing or adding to their languages.

For many people, the idea of making deliberate decisions about language sounds unrealistic, arguing that languages are living and changes cannot be controlled. Aboriginal languages are changing extremely rapidly as they are used to discuss aspects of Western culture which are making a significant impact on communities (Black, 1993, p. 207). In some communities, there are distinct dialect differences among the languages spoken by young people, their parents and their grandparents (for example, Tiwi which is spoken on Melville and Bathurst Islands). Debates continue in many bilingual Aboriginal schools over whether the children should learn to read and write in the language they speak or in the language that their grandparents speak (a difference between a first language programme and a language maintenance programme).

As part of this debate, communities are saying that they want to make explicit decisions about how their language is developed to discuss new concepts. In a community such as that of the Kunibidjis, it is possible to engineer language. There are only 200 speakers in total. Only a few of these would be involved in discussing Western mathematics in school and in community council meetings. School, as a main user of this mathematical register, could control and manipulate students' use in the same way that schools in Darwin develop students' use of the English mathematical register.

There are a number of alternatives from which Aboriginal people can choose in regard to the development of a mathematical register for their own languages, so that they can determine what 'sounds right'. Three of these alternatives have been presented below as clear-cut 'either-or' scenarios. In reality, it is far more likely that people from the same language group would develop a maths register which would contain elements from all the alternatives depending on the maths knowledge they will be discussing. Different language groups would choose different ways of developing the maths register depending on their own needs and situations.

The alternatives have been described like those suggested for the development of mathematics programmes which incorporate traditional, indigenous mathematics. Mellin-Olsen (1987, p. 125) summarised Pinxten's proposed strategies for a Navajo geometry as follows:

(a) teach the Western system;
(b) elaborate the Navajo system for later integration into Western geometry;
(c) integrate the Western outlook within the Navajo world-view and in terms of the Navajo spatial model

These three scenarios can be related to alternatives for mathematics registers in Aboriginal languages:

(a') only use English to discuss Western mathematics;
(b') elaborate Aboriginal languages, so that they incorporate some English grammatical structures, in order that some mathematical concepts are more easily able to be discussed;
(c') integrate the Western mathematical concepts into Aboriginal languages, so that traditional Aboriginal grammatical constructs are used to discuss these Western mathematical concepts

No alternative is inherently better than the others; schools and communities will choose the maths register which best suits their needs either by choosing one of the alternatives or

by using parts from different alternatives. Alternative (a') is by far the simplest in implementation, as it requires no community discussion about engineering languages, although it may have long-term ramifications on the use of the vernacular language and its culture. The choice to use different languages to talk about different things could result in the Aboriginal language only being used in ceremonies or other traditional areas and not being the language used in everyday situations. However, if alternatives (b') and (c') are chosen, either in part or as the only choices, then the communities would have to spend much time and effort in discussing how these would be implemented. Language engineering is by no means an easy process.

For example, as part of a pre-service activity (Batchelor College, 1994), Aboriginal teachers identified the English language elements in a maths activity in which they had just participated. They were then asked to think about the features of their own languages they would have to teach students if they were to undertake the activity in their own languages. In their reflections on the whole day's activities, the teachers wrote that it was very difficult to translate some of the Western mathematical ideas into their own language.

Some maths and language examples

Different world-views

The way that someone looks at the world and analyses it will depend on their world-view. For instance, if three people were sitting looking at a bush, they may in fact see three different bushes.

- A *botanist* may see it as an example of a specific type of bush, which she would know by being able to attach its scientific name to it. She might do this by looking for specific characteristics such as how the leaves are arranged on the branches.
- A *gardener* may instead try to identify the plant as being native or exotic to the area and look for evidence of how well the plant was thriving. This could be done by checking the colour and density of the foliage and looking in the immediate environment for anything which was inhibiting or encouraging growth.
- A *photographer* on the other hand may only see the interaction of light through the leaves and as a result consider how best to frame it.

None of these world-views is exclusive: just because you value some particular aspects more than others does not necessarily mean that you are unable to see those aspects that others do. Although the world-view in this example could be said to be determined by the individual's own micro-culture, all three people obviously belong to the broader Western culture: their viewings of the bush would certainly highlight many of the same characteristics.

Aboriginal people living a traditional lifestyle who look at that bush may not see the bush as an object in itself but as something with which they have a relationship. They would be more likely to see it as a provider of food, shelter or firewood for themselves and their family. What they value as important about the bush is different from myself because I buy my food from a store, use a house to provide shade and cook on a stove. The aspects which are highlighted by world-view are done so through the language of the particular culture, whether macro or micro.

Halliday (1978) has summarised how languages both reflect and shape the different world-views of people from different cultures:

> languages have different patterns of meaning - different 'semantic structures', in the terminology of linguistics. These are significant for the ways their speakers interact with one another; not in the sense that they determine the ways in which the members of the community *perceive* the world around them, but in the sense that they determine what the members of the community *attend to*. (p. 198)

As a member of Western culture, there are very few conversations in which I do not quantify by talking about how many, how long, how big or how much. It seems to me that I do this so that I can place myself in the world by making comparisons about the things which affect me. On the other hand, it also seems to me that my Aboriginal friends would not hold a conversation without referring to the relationships they have with people and things. Rudder (1983) has suggested that Yolngu people from north-eastern Arnhemland:

> do not use any form of quantification or measurement, but that all their evaluations are qualitative. (p. 7)

In many classrooms in English-speaking countries, there are students who do not have English as their first language. For many teachers who have read Cummins' (1981) work on the difference between Basic Interpersonal Communicative Skills (BICS) and Cognitive/Academic Language Proficiency (CALP), it provides some understanding of why some students from non-English speaking backgrounds were not performing well at school even though their conversational English was good. It becomes clear, however, that when you examine how another culture values the world and encodes that world-view in language, then knowing how to make a grammatically correct English sentence is not sufficient to help these students achieve in a subject such as Western mathematics. The differences between Aboriginal culture and Western culture are very obvious and it is easy to see that there will be interference in learning Western mathematics between how an Aboriginal child views the world and how Western mathematics expects the child to view the world.

On the other hand, studies have shown that students who have literacy in two languages are more likely to be lateral thinkers (Gibbons, 1994, p. 2). If alternative (c') were used (in part or whole), then some Aboriginal people could learn the same mathematics concept through both their first language and in English. As the two languages may highlight different aspects of that concept, these Aboriginal people would have a broader understanding of the concept. Lopez-Real (1997, p. 319) examined how Chinese-first speakers in Hong Kong solved English word problems involving algebra. He found that some students gave correct answers involving subtraction rather than addition (which was expected). If the word problems were translated into Chinese (e.g. 'p is 6 more than q' becoming instead something like 'p compared to q is larger by 6'), then the syntactic and semantic differences which resulted suggested that a sub-

traction was needed Some students could see and could use both paths to a solution However, in order for Aboriginal people to develop these broader concepts, the Aboriginal language needs to have a fully developed mathematical register which reflects the world-view embodied in that language

As quantification is done so differently in Western and Aboriginal culture, I have chosen to take mathematical examples from this area, in order to highlight some issues arising from using Aboriginal languages to talk about Western mathematics

Although there are some similarities among them, not all the features that I mention about Aboriginal languages will be valid for all Aboriginal languages Languages from central Arnhemland (such as Ndjébbana) are quite different from the Aboriginal languages of most of the rest of Australia which have much closer grammatical structures to one another Wherever possible, I have tried to specify the language when describing particular features

The individual features of the mathematical register in English can be described, but, in reality, these features interact with each other In English, these features include: specific vocabulary items, use of logical connectives and cohesion markers, extensive use of nouns or nominalisations and mathematical metaphor (Roberts, 1992, p 48) As an instance of such interconnection, if the English mathematical register did not use nouns or nominalisations, then it would be difficult to use metaphors which are developed through nouns

Logical connectives and cohesion markers

In Aboriginal languages, many of these linguistic features of the English mathematical register are available, so that alternative (b') could be implemented For example, there are a number of different ways of making complex sentences where one clause is dependent upon another Such a sentence could be: when we were swimming it started to rain 'It started to rain' is the main clause and 'when we were swimming' is a dependent clause providing more information about when it started to rain In English, connectives such as 'then', 'because' or 'so' are used to mark logical relationships between clauses, and which differ from temporal connectives and other markers of text cohesion

Pitjantjatjara highlights a dependent clause in a sentence by adding an ending to the verb in that clause Thus, you are able to have dependent clauses showing the sequence of events, the circumstances of the events, the purpose of the events, the intention of the events and relationships among the events There are also independent words indicating time relationships such as 'afterwards' or 'again' in English However, these do not always need to be included to explain the sequence of events

Another central feature of the English mathematical register is the use of hypothesising language to discuss events which *may* happen Such language is usually developed through the use of logical connectives (such as 'if ..., then ...' or 'because') and a particular verb form (in English, the modal forms 'would' or 'could')

There has been much discussion in the last few years over whether Aboriginal languages allow for the discussion of non-real events As Harris (1991, p 19) has observed, Aboriginal languages are able to express hypothetical events (e g showing an 'if ..., then ...' relationship between events by using one of the Pitjantjatjara verb endings), but it is very rare for speakers to do so (see also Eckert and Hudson, 1988, pp 264-270) It is far more likely that two events related in this way would in fact be talked about separately, and that the listener would be expected to make a connection between the events The relationship is implicit and you need cultural knowledge in order to react appropriately to it

For example, in English an appropriate sentence could be 'If I had a fishing line, [then] I could go fishing', but in Pitjantjatjara it is more likely you would talk about the fact that you had no fishing line and that you wanted to go fishing It is then the responsibility of the listener to make the connection and provide a fishing line so that you could go fishing It is extremely impolite to ask for anything directly in many Aboriginal communities Prevarication is expected and is culturally important, so that the relationship between people is maintained

Nominalisation and metaphor in English

Children learn to count material things, and to do this they use number words as adjectives: one banana, two bananas, etc The terms describe the bananas by providing information on the quantity To reinforce the difference between the singular and the plural, the noun changes form, from 'banana' to 'bananas' In English, almost everything can be quantified in this way Exceptions are such things as mass nouns such as 'rice' or 'water' which cannot be individualised, and abstract quantities such as 'strength' or 'height' (Coleman, 1995, p 22) Both of these types of non-countable nouns are quantified in different ways; some by the imposition of a formal measurement system such litres or centimetres, and others by using comparatives and superlatives, e g 'she is stronger than me' or 'I am the tallest'

Once, however, children start to use numbers in arithmetic and not to count things, they are in fact using numbers as nouns As nouns, they are accepted as having an identity in their own right and they themselves can then be acted upon or described There is a substantial difference between putting two apples together with two more and adding two to two

Numbers as nouns carry many layers of meaning in English, whereas adjectives do not carry such layers With numbers, children might learn that the number refers to a particular amount, and then learn how each number is related to all other numbers They also learn that numbers can be whole numbers, rational numbers, irrational numbers and can be related to algebraic expressions

When children learn the word 'triangle', for instance, as a non-counting example, they are in fact learning that that particular shape has the name 'triangle', and is to be attended to As they become older, they learn that triangles are triangles because they have three sides and three corners Children then learn that triangles belong to the set of two-dimensional shapes and triangles can be compared with other two-dimensional shapes Later, they learn that the corners are angles and the sum of the three angles always adds to 180° Later still, triangles became related to Pythagoras' theorem and are

used for finding the sine, cosine and tangent of angles. 'Triangle' therefore carries many related meanings.

Adjectives may have different related meanings. For example, a 'big' dog uses the word 'big' differently from a 'big' tree. However, adjectives only have one meaning when they are used in a specific situation: they do not carry layers of meaning at the same time in the way that nouns do.

Halliday (undated, p. 7) states that in scientific discourse: "the events themselves have become nouns; while verbs are used to express the relationship between them". In the sentence 'two plus two equals four', a reader or listener should interpret the expression 'two plus two' as having noun-like qualities, as a static thing. However, the nominalisation carries the action instead of the verb, whereas in most conversational English it is the verb which carries the action. 'Equals' is the main verb in the sentence and it tells of the relationship between the nominalisation 'two plus two' and the noun 'four': it is not an action word. 'Plus' has much more of a sense of action, but belongs to the nominalisation.

This discourse pattern allows for the grammatical metaphor found in the English mathematical register to be developed (see Pimm, 1987). Halliday is uncertain whether regardless of which language is being used mathematical ideas need to be described by nominalisations (1978, p. 202). He has also commented on how the use of nouns to carry meaning has the effect of taking people and culture explicitly out of mathematical discussions: the knowledge itself appears to exist independently of humans and hence to be objective.

Nominalisation and metaphor in Aboriginal languages

Nouns can also be used to carry abstract concepts in Aboriginal languages. However, in such languages, nominalisations do not describe processes in the way that they do in the English mathematical register. For instance, in the teacher education workshop mentioned above (Batchelor College, 1994), student teachers had problems in deciding on terms in their own languages which were equivalent to 'quarter' and 'half'. Sometimes, the word chosen was the verb for 'dividing into parts' and this verb would be used for both 'quarter' and 'half'.

If a community chose alternative (c') in developing their mathematical register, then verbs rather than nouns would probably need to carry the processes. In both Pitjantjatjara and Ndjébbana, sentences can consist of verbs with affixes providing necessary information such as object or subject determination. These sentences also gain meaning from the events which are happening around the speaker and listeners. The use of verbs to carry the processes in Aboriginal maths registers would result in the processes remaining active, and it may be that participation of people in the action would also remain much more in evidence.

However, specific things are quantified in Aboriginal languages. Pronouns show the difference between one, two and three (and more) people. In English, there is no way of telling whether two or more people are being talked about when terms such as 'they' are used. In Aboriginal languages, as in Maori, Greek and some Semitic languages, there is a difference between a pair and more. In the Dhuwal and Dhuwala language-speaking groups of north-east Arnhemland, a distinction is made between three and a group of more than three people by the addition of terms to the pronoun (Rudder, 1983, p. 66). In some languages, such as Ndjébbana from central Arnhemland, separate pronouns in sentences are not needed and the pronoun information is attached as a prefix to the verb. Affixes to Aboriginal languages from central Arnhemland provide information about the numerosity of the object and the subject (Coleman, 1995, p. 26). By examining the affixes, for instance, it is possible to tell whether many mangos were collected by one man or whether many men collected one mango each.

Other nouns can be counted depending upon the category to which they belong. Speakers of the Aboriginal languages of central Arnhemland only count higher animates (Coleman, 1995, p. 24). Higher animates are things to which are assigned the pronouns 'he' or 'she' in English such as Aboriginal people: non-Aboriginal people in Aboriginal languages often belong to the category of 'other animates', which includes such things as bird and snakes (Walsh, 1993, p. 115).

Christie (1995) relates how when bilingual education started in the Northern Territory, there were attempts to create counting systems in Aboriginal languages. These were used to count a range of things, not just those things which were traditionally counted, and the number terms were also used as nouns in the English mathematical register sense. These counting systems used the counting words available and then put those numbers together to make other numbers. Four, for instance, can be made from 'twotwo'. However, the number names become huge very quickly and no Aboriginal languages that I am aware of still uses those 'engineered' numbers. When specific engineering of a language makes it too cumbersome, then language speakers will chose other ways for expressing the same meaning. This has significant implications if Aboriginal communities engineer their languages to develop mathematical registers.

Harris (1987, p. 35) recounts how a well-known Aboriginal person in the Northern Territory counted past 1200 in 1981 using only the resources of his first language. Certainly this man understood Western mathematical concepts of place value and he did not say that Aboriginal people traditionally counted that far using these terms. However, his point was that Aboriginal people were capable of counting in their own languages if they had a need to do so. Harris (p. 32) puts forward the proposition that traditionally there were terms for large numbers in many Aboriginal languages and they could have both precise or imprecise meaning depending on the context in which they were used.

Aboriginal children learn to count very easily using English number names. In testing children at Maningrida, it was found that Aboriginal children count as well as their non-Aboriginal peers up to the age of nine. Even three-year-olds in the pre-school exhibited some counting behaviours, pointing to a series of objects one after the other. However, my experience is similar to Christie's in that I feel that students do not always understand the cardinality of numbers. Three is three because it contains three objects, but there is also a need to know that three is 'one more than two' and

'one less than four' Some students do not have a sense of the multi-layered nature of the nouns This knowledge may need to be made explicit to students regardless of which language they learn their maths through.

Halliday (1978, p. 203) suggests that where a natural language does not have a term for a particular concept, and as a result a term is then created to carry this meaning, the layers of meaning which are associated with mathematical terms will take much longer to develop. English number names are so entrenched within Aboriginal communities, that it could seem pointless to introduce a number system based on Aboriginal names However, it cannot be presumed that the layers of meaning that English speakers associate with the numbers are also available to Aboriginal language speakers who use English number names. As a teaching point, it may be useful to show children how Aboriginal languages could make up numbers by joining traditional counting words together. This could then be related to how the Hindu-Arabic number system also builds up numbers by placing digits together.

Harris (1987) relates a story of an old woman who demonstrated her counting ability in her own language by dividing a set of pebbles as though they were turtle eggs. He concludes the story by stating that:

> Aboriginal people in this context saw *division* (sharing) rather than *addition* (accruing) as the essential role of counting (p. 36)

Sharing reflects the importance of the relationships between people, but it is also quantifying Any mathematical register in Aboriginal languages will reflect the fact that mathematics in Aboriginal communities is intimately related to the relationships among people and between people and things. It is unlikely that in Aboriginal languages that knowledge can be represented as having no relationship to people, as it does in the English mathematical register by the extensive use of nominalisations.

Metaphor is used extensively in Aboriginal languages (Watson, 1988, p. 5). As an example of the use of metaphor, in the Garma maths programme used at Yirrakala, in north-east Arnhemland, Yolngu and Western knowledge are integrated within the maths programme The concept of skinship is used to illustrate recursive patterns and then these are related to the patterns found in the number system such as the use of 0 to 9 within the place-value system to build up bigger and bigger numbers.

'Skinship' is the term used to describe how every community member is related to every other community member. As a child, you are born into a particular skinship group, which is determined by who your parents are. Any other community member who also fits into the same groups as those of the parents must also be treated as parents by the child. These others, of course, would include the sisters of the mother and the brothers of the father. Every community member belongs to a skinship group and as a result every child learns how to relate to everyone else in the community.

Understanding this very complex relationship is extremely hard for non-Aboriginal people However, most Aboriginal children will have a complete understanding of it by the time they start school. In fact, the first name that Aboriginal children in Maningrida are expected to learn is not their individual name but the name of their skin group which also becomes their name (Maningrida CEC, 1997) [2]

Some Aboriginal people have expressed concern about relating traditional knowledge to western mathematics As a person from Western culture, I tend not to value other cultures' knowledge unless I can fit it into my own knowledge base. As a result, I question and examine this knowledge so that I can understand it. By relating others' cultural knowledge to Western mathematics, I run the risk of dismissing this knowledge as not being valid in its own right and forgetting the cultural norms about how knowledge is to be regarded (in Aboriginal culture knowledge tends to have an unquestionable status) Communities once again are the only ones who can make decisions about whether their knowledge is to become part of the schooling process and set the rules for how it is to be taught and treated in schools

Discussion of alternatives (a'), (b') and (c')

Over the next few years, mathematical registers in Aboriginal languages will be developed, whether as a result of explicit decisions or not As more people discuss Western mathematical ideas in Aboriginal languages, some structures will begin to 'sound right' As particular structures become used by the majority of people, opportunities for language engineering will no longer be available If explicit decisions are to be made about mathematical registers in Aboriginal languages, they need to be made now

For some communities, alternative (a') will be the choice they make, as is the case in many parts of the world where other indigenous communities are learning Western mathematics. If English is chosen to teach Western mathematics, then many of the features of the English mathematical register will need to be taught explicitly with the appropriate knowledge of world-view. Understanding of Western cultural views will not only allow Western mathematics to be understood clearly, but will also be useful in solving mathematical problems outside of school

However, in other Aboriginal communities, a choice has already been made to use Aboriginal languages to discuss Western mathematical ideas. For these communities, informed decision-making about the changes to their languages will involve discussing the issues raised by alternatives (b') and (c').

In many studies, Aboriginal culture has been described as qualitative rather than quantitative (Harris, 1987, p. 34). Relationships between people are of major importance in the world-view of Aboriginal people. It seems unlikely that knowledge can be discussed unless the relationships are made clear. Certainly, Aboriginal people who use the English mathematical register may feel dissatisfied with it because processes are distanced from people by the use of nominalisations.

Within the Aboriginal world-view, some things, such as people and other higher animates, are quantified. Aboriginal languages also contain many of the features of the English mathematical register, such as metaphors and hypothetical verb forms. Although some of these were not used extensively, they could be developed so that they are available to

be used to discuss Western mathematical ideas. Choosing alternative (b') for a mathematical register could involve some change to the culture, as certain grammatical structures became important which before only had minor roles in conveying meaning. This impact could be reduced if these structures were restricted to the mathematical register and were not used in other registers of the language. It is difficult to know how realistic it would be for a community to enforce such a restriction.

With alternative (c'), the use of traditional Aboriginal languages' grammatical structures would involve developing such things as verb affixes so that they could be drawn on to discuss Western mathematical concepts. In order to ensure that this language engineering was successful, the language must not become too cumbersome. The abstract nature of number, which is fundamental to Western mathematics, would need to be developed in Aboriginal languages if Aboriginal people wanted to use their own languages for discussing Western mathematics.

Although this article has focused primarily on linguistic choices, the main question is not so much which language but how two world-views can be blended, so that they add to Aboriginal students' ability to interact with the world in which they live rather than subtract from it as a result of students falling between cultures by not having a firm enough grasp of either world-view. Aboriginal students from remote communities are expected by their families to gain Western knowledge while retaining their Aboriginality. Western knowledge should not replace Aboriginal knowledge.

Using different languages can have the effect of highlighting some aspects of a concept while others may be noted but not extended. If students learn Western mathematics through English, they will still need to be taught explicit cultural knowledge in order for the mathematics to be of any use to them. This then leaves to the students themselves the question of how to blend this Western world-view with their Aboriginal world-view. If, however, communities decide to make choices about engineering languages, to a certain extent they have also taken on the responsibility for deciding how the two world-views are to be blended. The choices about the changes to Aboriginal languages will reflect how the communities want the two world-views to be blended.

Notes

[1] See the article by Barton *et al* (1998 - this issue) about the situation with the Māori mathematics register in this regard.

[2] There have, in fact, been several descriptions of skinship, seeing it as an 'example' of Western mathematics. Many Aboriginal people resent the representation of this knowledge as mathematics, feeling that the knowledge is valuable in its own right. To them, it does not need to be explained or justified as an example of equivalence classes, as exhibiting a group-theoretic structure or as a means of minimising inbreeding in a small population society. It is as if we can only understand something by overlaying it with something from our own culture, and if we cannot do that then it is not valuable.

References

Barton, B., Fairhall, U. and Trinick, T. (1998) 'Tikanga reo tātai: issues in the development of a Māori mathematics register', *For the Learning of Mathematics* **18**(1), 3-9

Batchelor College (1994) *Teacher education maths workshop Stage 3*, 24/10/94-28/10/94.

Black, P. (1993) 'New uses for old languages', in Walsh, M. and Yallop, C. (eds), *Language and Culture in Aboriginal Australia*, Canberra, Aboriginal Studies Press, pp. 207-223

Christie, M. (1995) 'The purloined pedagogy: Aboriginal epistemology and maths education', paper presented to Australian Association of Mathematics Teachers Conference, Darwin, July, 1995.

Coleman, C. (1995) '"Number" in Top End Aboriginal languages', *ATESOL NT Inc. Newsletter* 8, 22-33.

Cummins, J. (1981) 'Empirical and theoretical underpinnings of bilingual education', *Journal of Education* **163**(1), 16-29.

Eckert, P. and Hudson, J. (1988) *Wangka Wiru: a Handbook for the Pitjantjatjara Language User*, Adelaide, South Australian College of Advanced Education.

Gale, M. (1994) '*Dhangum djorra'wuy dhawau*: a brief history of writing in Aboriginal languages', *Aboriginal Child at School* **22**(1), 33-44

Gibbons, P. (1994) *Learning How to Learn in a Second Language*, Sydney, Primary English Teachers Association

Halliday, M. A. K. (undated) *The emergence of scientific English*, unpublished lecture notes, Sydney, Sydney University

Halliday, M. A. K. (1978) 'Sociolinguistic aspects of mathematical education', in Halliday, M. A. K., *Language as Social Semiotic*, Edward Arnold, London, pp. 194-204.

Halliday, M. A. K. and Martin, J. R. (1993) *Writing Science: Literacy and Discursive Power*, London, Falmer Press

Harris, J. (1987) 'Australian Aboriginal and Islander mathematics', *Australian Aboriginal Studies* No. **2**, 29-37

Harris, S. (1985) 'Constraints on effective use of language for learning in Aboriginal Schools', Plenary address to the Working Conference on Language in Education, Armidale, New South Wales

Harris, S. (1990) *Two-Way Schooling: Western Education and the Survival of a Small Culture*, Canberra, Aboriginal Studies Press

Harris, S. (1991) 'Reply to McConvell's two-way blind alley paper', *Australian Aboriginal Studies* No. 2, 19-26

Lopez-Real, F. (1997) 'Effect of the different syntactic structures of English and Chinese in simple algebraic problems', in Biddulph, F. and Carr, K. (eds), *People in Mathematics Education. Proceedings of MERGA-20*, Vol 2, pp. 317-323.

Maningrida CEC (1997) *Aboriginal Forms of Assessment*, Maningrida, Northern Territories, Maningrida CEC.

Mellin-Olsen, S. (1987) *The Politics of Mathematics Education*, Dordrecht, Kluwer Academic Publishers.

Pimm, D. (1987) *Speaking Mathematically: Communication in Mathematics Classrooms*, London, Routledge and Kegan Paul

Roberts, T. (1992) 'Maths, language and Aboriginal students', *Mathematics: Linking Learning and Teaching, Collected Conference readings, papers and notes from Maths Meet 1992*, Darwin, Mathematics Teachers Association of the Northern Territories, pp. 43-55

Rudder, J. (1983) *Qualitative Thinking: an Examination of the Classification Systems, Evaluative Systems and Cognitive Structures of the Yolnu People of North-east Arnhem Land*, unpublished M.A. thesis, Canberra, Australian National University.

Walsh, M. (1993) 'Classifying the world in an Aboriginal language', in Walsh, M. and Yallop, C. (eds), *Language and Culture in Aboriginal Australia*, Canberra, Aboriginal Studies Press, pp. 107-122

Watson, H. (1988) 'What is this thing called mathematics?', *Report from Mathematics/Science Strand Workshop, Stage 2*, Batchelor College, Batchelor, Northern Territory