Bridging the Gap:
Bicultural Teacher Training in Mathematics Education for Aboriginal Trainees from Traditional Communities

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Introduction

This paper will discuss the challenges facing an educator in the development of a bicultural, bilingual teacher training programme in mathematics curriculum for Aborigines from traditional communities. The course described forms part of the Anangu Teacher Education Programme (ANTEP) an accredited teacher training course intended for traditionally oriented Aboriginal people currently residing in the Anangu communities who wish to take on greater teaching responsibilities in South Australian Anangu schools. The course will be directed from the South Australian C.A.E. but most teaching will be carried out on site by a lecturer residing within the communities. Pukatja (Ernabella) will be the host community for the project.

The programme as a whole represents a significant departure from conventional teacher education in a number of ways. Perhaps the most striking difference between this teacher training course and many others is that from the beginning, development of the curriculum has been a co-operative venture between lecturers and educators on the one hand and community leaders and prospective students on the other. The extent of this co-operation is indicated by French-Kennedy's (1984) description of the aims of the curriculum design workshop held in April 1984.:

> The general aim .... was to bring together prospective ANTEP students; interested Anangu; non-Anangu with demonstrated expertise in the area; the relevant ANTEP lecturers in charge and the onsite lecturer for the purpose of considering, in detail, the initial offering of units.
>
> (page 3)

The first group of students will commence the course in August, 1984.

The tone of the early negotiations with the Anangu communities indicated that an interactionist perspective on bicultural education and on mathematics education and curriculum development in particular would be most appropriate. The rationale for the design of the two

units Teaching Mathematics I and II that form the mathematical component of the course has evolved from the urgent need to provide experiences that will enable students to negotiate the complex interacting factors from the known in their own culture to a competence in the use of mathematical ideas from Anglo-European cultures. The perceived community needs in Western mathematics were eloquently stated by one member of the community as follows : "Our children need to know enough maths so they don't get ripped off."

Initial discussions with community leaders and prospective students suggested the following general aims for the course :

1. Development of student awareness of their cultural expertise in -
   a) the Anangu ways of thinking about relationships and patterns to do with the locations, qualities and quantities of objects and people in the environment;
   b) the needs of the Anangu community to -
      - affirm Anangu culture and Pitjantjatjara language;
      - develop new strategies and mathematical knowledge to meet the need for dealing with Anglo-Europeans and their culture
      - to explore traditional ways of teaching young children and the modification of these methods as necessary to accommodate new knowledge.

2. Widen student awareness of and ability to apply elementary mathematical knowledge (S.A. Curriculum K-8) to solve community problems.

3. To enable students to develop a rationale for teaching behaviour and methods that are appropriate to the needs of the children of the community.

Negotiating Meanings Between Two Cultures

Gay and Cole (1967) examine the teaching of mathematics in a cross cultural situation. They suggest :

> ..... in order to teach mathematics effectively, we must know more about our students. In particular we must know about the indigenous mathematics so that we can build effective bridges to the new mathematics we are trying to introduce.
>
> (page 1)

The need to build conceptual bridges from the known to the unknown is not of course an educational problem restricted to the context of bicultural education. The mathematics curricula in most primary and secondary schools are notably dissociated from the everyday concerns of the student population. This has been a cause for considerable concern among mathematics educators in an increasingly technological society. In a bicultural context the situation is made more serious by the fact that different cultures emphasise different conceptual schema. Thus, temporal sequences and quantitative measurement are dominant themes in industrialized Western cultures but largely irrelevant in traditional Aboriginal cultures. Scientific and technological thought, the appropriate registers of language and mathematics as an abstract discipline have developed over hundreds of years within Anglo-European culture and reflect these dominant themes particularly at the elementary level. Experience suggests that for many Aboriginals from traditional communities the content of the elementary mathematics curriculum is perceived as incomprehensible and often irrelevant.

There has been a great deal of valuable descriptive research by J. Harris (1979), Dasen (1970), Keirins (1976), Rudder (1983) and others about the kinds of classification systems and the rate and order of development of concepts related to mathematics in differing Aboriginal cultures. The work of Pam Harris[1] provides an account of the effect of these differing cultural perspectives on mathematics learning. Her detailed and historical accounts of Aboriginal attitudes and beliefs about such topics as money, measurement and number provide a valuable resource for teachers. Her work is important in combatting the negative expectations expressed by teachers in such statements as : "Aboriginal children do not generalize".

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(1) Personal correspondence and CDC Mathematics in Aboriginal Schools Project Series - In Press.

The clear accounts of how Aboriginal children do generalise and why they find school mathematics difficult are instructive. Her explanations of how these difficulties may be overcome redirect the focus of the problem from the 'failings' of Aboriginals and Aboriginal culture to the inappropriateness of many teaching practices for children from traditionally oriented communities.

Most recently published curriculum materials such as those devised by Western (1979), Northern Territory Department of Education (1982) and Guy (1982), intended for use by Aboriginal teacher trainees or as resources for teachers in Aboriginal schools have acknowledged the implications of J. Harris's (1979) statement :

> As the child matures learning to label and order his experiences it is inevitable that his cognitive development will be very strongly influenced by Aboriginal systems of knowledge.
>
> (page 143)

Thus, these materials take care to acknowledge language difficulties, use materials from a familiar context for illustration and take particular care in topics such as time and measurement to provide experiences to facilitate conceptual development. However a closer analysis of such materials suggests that the teaching procedures and the content are still culturally biased to the extent that Aboriginal people are likely to have difficulty relating school experiences in mathematics to community needs and problems.

In a community based teacher training course it seems that it is possible for the first time to develop procedures for negotiating meanings between the two cultures. With this in mind the lecturers notes at the beginning of the first module in the course state :

> A co-operative exchange of knowledge is particularly important in the tutorial sessions because mathematics by its nature involves the use of higher order cognitive skills and problem solving requires confidence. There is considerable research evidence to suggest that egalitarian relationships foster these skills better than authoritarian directions. It is important that student/teacher interaction and role play used in the sessions provide a suitable model for interaction with children.
>
> (Teaching Mathematics I, Module 1)

The course has been developed based on a model designed to maximise the possibility of interaction between the world view expressed by Anangu culture and that of Anglo-European culture as evidenced in school mathematics. This is achieved by placing an emphasis on the student expertise and contribution in providing information about Anangu world views as a necessary part of the course. The course is constructed in such a way that students are invited to participate in co-operative decision making about appropriate methods for negotiating meanings from one culture to another.

Group interaction and co-operation in arriving at solutions to the problems set by tasks in each module are an essential component of course experiences. This is a necessary process if an understood social concensus about the multiple realities, perceived by Anangu and non-Anangu tutorial group members is to be achieved. Such cognitive interaction is the basis for the development of a synthesis of world views and of the clearly understood and generalised universal premises that will form the basis for future group decision making. The outcomes of such a synthesis are in the changed perspectives that the participants take away with them.

Figure 1 below illustrates some of the contexts in which this approach will be used.

It is expected that in Teaching Mathematics 1 the mathematical content will be that of the South Australian Department of Education Syllabus's Early Childhood section (Modules 1-10). In the second year of the course the emphasis will shift to the mathematical content of the upper grades of primary school. The community has expressed the desire that teacher trainees should function as a resource of useful mathematical knowledge within the community. To meet this need there will be a mathematics component in the Work Skills Unit that is also included in the ANTEP programme.

FIGURE 1

	CONTEXT	PROBLEM-SOLVING STRATEGIES	LANGUAGE USE	MATHEMATICAL CONTENT	TEACHING STRATEGIES For generalization and concept development	TEACHING STRATEGIES For rote learning of conventions
ANANGU (Students contribution)	Self group survival and cultural activities	Anangu ways of solving problems related to : classification, space, quantities, measurement.	Pitjantjatjara vocabulary and syntax development to be decided by students.	Increase student awareness of mathematical ideas in Anangu culture. Explore needs for differend knowledge and ideas to solve problems arising from wider experience including Anglo-European contact.	Begin with Anangu learning methods and important cultural themes.	Begin with Anangu learning methods.
Group decision making	Cultural interface	Used as a basis for discussion of :		Methods for bridging cultural differences.	Compare and contrast with different methods that are important in individualized society.	Compare and contrast with course outcomes.
ANGLO-EUROPEAN (on site lecturer and resources contribution)	Wider contexts including : Anglo-European contact - trade - employment, etc.	Anglo-European ways of solving problems in a more complex and industrialised culture.	Use of appropriate English vocabulary as necessary and appropriate.	1. Early Childhood curriculum content. Early Primary. 2. Middle grades 5-8 curriculum content. S.A. curriculum.	1. Establish relationships or parrerns (use visual input as appropriate). 2. Change contexts. 3. Change quantities (if appropriate). 4. Develop links with other related concepts. 5. Use the new knowledge to solve problems.	1. Use of song, rhythm and movement. 2. Practice. 3. School experience in using skills.

A system of clustered modules has been used in the course so that conceptual construction links between related topics are made as explicit as possible. The diagram below illustrates the first twenty modules of Teaching Mathematics 1.

Module 1

What is mathematics?

Anangu needs and problems in mathematics

Classification Modules 2-5

2. Classification and Grouping 1 - Anangu way.
3. Classification and Grouping 2 - according to position.
4. Classification and Grouping 3 - size.
5. Teaching methodologies for classification.

Comparison and Ordering

Modules 6-10

6. Comparison 1 - feeling objects.
7. Comparing people - ordering and posture.
8. Ordering objects and events.
9. Comparing and ordering groups.
10. Developing teaching methods for comparing and ordering.

Early Ideas of Number

Modules 11-15

11. Analgu terms for quantity - uses.
12. 1:1 matching - showing more-same-less.
13. Equivalence - exchange grames - trading.
14. Using grouping to describe quantities < 10.
15. Counting to 10. Counting by 10's.

Measurement

Modules 16-20

16. Measurement of length and distance.
17. Measurement of area.
18. Measurement of volume.
19. Money - how much?
20. Money - equivalence, i.e. how much work? how much pay? how much money? how much food?

Figure 2

The experiences provided for students during the course have been chosen so that the links between mathematical ideas as expressed in traditional Anangu culture, the settlement community, Anglo-European culture and the school curriculum emphasised.

Most modules are constructed to promote an exchange of ideas between the distinctly different conceptual frameworks of the two cultures. The diagram below shows some of the ways in which this occurs.

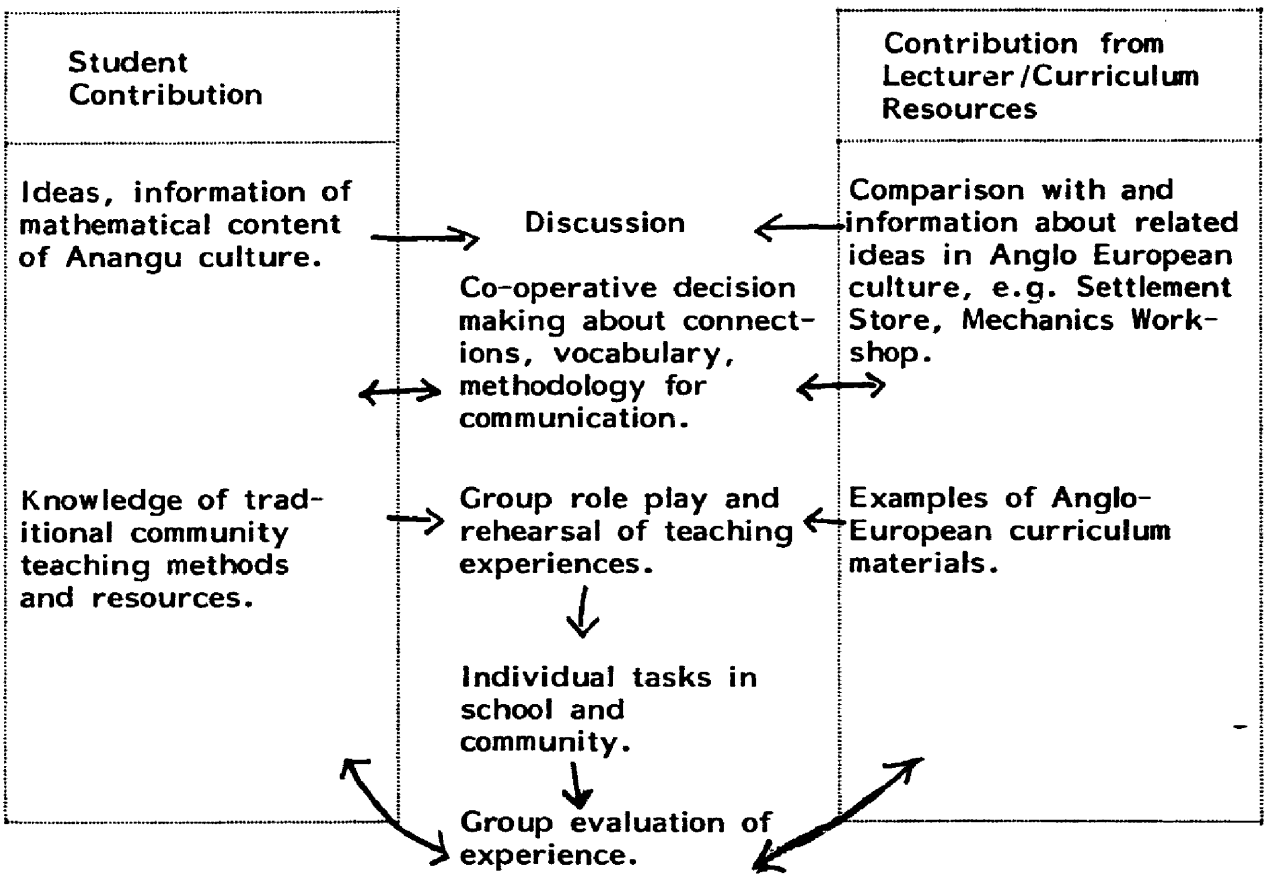

Figure 3

At all points emphasis is placed on practical experimentation and application of ideas in the community and the local school. The teaching staff at Ernabella school has been most supportive of the programme and is enthusiastic about allowing students to expand their practical experience within the school as their skills increase.

Communication Between Cultures

During the development of this course it has been necessary to pay considerable attention to the communication difficulties of a bilingual programme. For some of the reasons expressed in the previous section language difficulties are particularly evident in the mathematics area. Barbara Sayers (1983) suggests that language difficulties are a particular problem in the teaching of mathematics. She goes on to describe her experience at the Wik-Mungkan community at Aurukan :

> I have understood what was said in terms of understanding the linguistic aspects of the language, but I have not understood the message they encoded. Such messages are incomprehensible because I did not understand the presuppositions on which they were built, nor the Aboriginal concepts which were involved. To sum up, I could understand what was said but not what was meant.
>
> (page 3)

The reverse situation occurs all too often when mathematics is taught in Aboriginal schools.

Some proficiency in English has been required for selection to the ANTEP course. However on-site experience at Ernabella suggests that :

1. Bilingual presentation of materials is essential.

2. Articles and workbooks should include English and Pitjantjatjara translations.

3. Participant responses were always in Pitjantjatjara with the exception of one person.

4. Difficulties will be experienced in translating some English words into Pitjantjatjara particularly in the field of mathematics.

The course has been designed with considerable emphasis on an activity based process/discovery learning design to maximise the possibility of concensus about the meaning of language generated by students (in either language).

It has also seemed appropriate to maximise the superior visual/spatial skills of the Anangu people, and the precision of the Pitjantjatjara language in this respect, by illustrating concepts by role play or diagram as far as possible. For example in Module 7 of Teaching Mathematics 1, posture, which is an effective and important means of communication within the Anangu communities, is used extensively in an action based activity to convey ideas about seriation. During the development of the course students will be encouraged to develop techniques for using graphic displays to convey relationships.

The Ernabella school has an Apple computor. Work has already been done by Klich (2) in converting spatial games known to community elders into a form suitable for presentation on a video screen. The prospective students have already expressed much interest in learning to use this computor. The development of cultural symbolism through the use of Apple Logo software seems an extremely promising medium for the introduction of Euclidean notions of geometry and sequenced procedural skills.

It has become evident that there is insufficient information available about the use of Putjantjatjara language in relation to mathematical concepts. In any case there has been some suggestion from members of the community that language development in the vernacular is somewhat depressed among settlement children. It seemed advisable to include in the course some action-based research for students directed at the collection of information about the ways in which Pitjantjatjara language is used to describe mathematical ideas.

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(2) Personal correspondence.

This seemed an important aspect of their learning because :

- on location experience with Aboriginal teacher aids suggests that their assistance of children even when expressed in the vernacular consists of, often incomplete, attempts to translate Anglo-European ideas rather than the out of school modes of expression. Confusion results.

- the procedure seems likely to provide experiences that will heighten student awareness of mathematical ideas and concepts within their own culture.

- Eagleson et.al. (1982) suggest that Aboriginal English is often a restricted code. Further, syntax often follows that of the Aboriginal vernacular. This form of language (without clarification) appears unsuitable as a basis for meaningful discussion about mathematical ideas from Anglo-European culture.

- the collection of information of this kind seems likely to heighten the awareness of both students and educators of points where confusion about mathematical concepts is likely to arise.

The inclusion of these types of exercises in the course was confirmed as a useful innovation by David Wilkins, linguist, of Yipirinya school in Alice Springs. The teachers at that school have found a similar approach most useful, especially for mathematics. Prospective students were enthusiastic about the idea since it affirms their cultural expertise and provides opportunities for consultation with community leaders about precise vocabulary.

The procedure as it has currently been developed involves collecting taped information of children and adult language usage to describe certain situations. For example, a child may be blindfolded and directed through a maze of carefully placed obstacles by the rest of the group to elicit information about vocabulary and syntax connected with location and direction. The school linguist, on-site lecturers and students then use the collected information as a basis for language

development in the vernacular and as a source of information about conceptual differences between cultures. For example, Anglo-Europeans tend to describe direction in terms of Left and Right, many Aboriginal groups use the four points of the compass.

There does not appear to be a set policy for bilingual teaching in the Ernabella school. In general the linguistic resources available and the language competence of children in either language govern the level of verbal discourse. In a bicultural context it is necessary to actively affirm language registers that are appropriate for discourse about science, technology and mathematics. This register of English language is not normally evident in the language-arts curricula of Australian primary schools. The teacher training experience provided in the courses described above, emphasises the use of small group co-operative tasks and elaborated ideas as logical and meaningful communication. It is hoped that these will provide students with the necessary skills to allow for needed curriculum change and a rationale for the appropriate use of first the vernacular and then English as a useful medium for instruction in mathematics.

Conclusion

The emphasis in the teacher training course described above has been in the development of a rationale for connecting the conceptual frameworks (with respect to mathematics) of two very different cultures.

Experiences have been provided to increase student awareness of the mathematical ideas within Anangu culture. Strategies have been suggested and opportunities provided for the development of a rationale for teaching procedures that will assist children as they move from one cultural context to another.

To this end, the course has been constructed on a process model where information is collected and students are encouraged to play an active role in the decision making about outcomes. Language development in both English and the vernacular will be an important factor in this process.

The visual/spatial knowledge and the heightened awareness of relationships that are characteristic outcomes of Anangu culture will be used in teaching procedures that emphasise these aspects of mathematics rather than demanding prior mastery of incomprehensible algorithmic procedures.

It is to be expected that there will be some problems to be negotiated as the course proceeds. At this stage, however, it seems that success, in terms of student competence as teachers and a more appropriate learning environment for the mathematics curriculum in Anangu schools, may well depend on the extent to which students are enabled to actively participate in building bridges between the two cultures for themselves. Only then will they become truly competent as teachers in a bicultural context.

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