

BUILDING BRIDGES BETWEEN ABORIGINAL AND WESTERN MATHEMATICS: CREATING AN EFFECTIVE MATHEMATICS LEARNING ENVIRONMENT.

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ABSTRACT

After the occupation of their land by Europeans, the Australian Aboriginal and Torres Strait Islander people were expected to benefit from an education system based on that of the dominant Europeans. Gradually educators realized that Aboriginal culture has validity and strength and that all children learn differently. In this paper the characterization of the Aboriginal learner is examined and pedagogical strategies to assist in both students' learning and teachers' delivery are explored. The message that is conveyed in this paper has particular relevance to teaching mathematics to Aboriginal learners as well as to the general curriculum. It is also of considerable value in teaching non-Aboriginal students.

INTRODUCTION

"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."

Gwen Bucknell (1995, pp 22) espouses the sentiments of many teachers trying to teach Western mathematical concepts to indigenous students. The quote above raises many issues of relevance to this paper such as communication and an Aboriginal pedagogy. Also of relevance is the awareness of the authors that if you wish to perpetuate inequalities then provide the same education for all.

Aboriginal culture is a complex, diverse continuum, from traditionally oriented people living in isolated communities with very little or no English language, to people living and functioning very ably in predominantly Western culture. The education system needs to cater for the consequent varying interests and cultural backgrounds of the Aboriginal students. Subjects which, by convention, have been taught to European standards and by European methods have to take into account their relevance to the Aboriginal student.

Mathematics is no exception. Indeed, many students of Western origins find difficulties in the mathematics curriculum offered in schools. Students whose language and culture is not based on Western customs often find these difficulties with mathematics compounded (Barton, 1996). Conversely, many of the insights and methodologies proposed in this paper to develop a more applicable and relevant mathematics curriculum for Aboriginal students, could be used to make mathematics more interesting, relevant and successful for all Australian students.

EDUCATION AND CULTURAL MINORITIES

In the multicultural society that is Australia, minorities often have difficulties in the education system (Haralambos *et al*, 1996, Davis & Maher 1993)). Table 1 reveals that this may result in feelings of alienation, powerlessness, fear, withdrawal, truancy, and lack of engagement or success. The writers' experience, research and observations in Aboriginal education reveal that the following reactions too often occur in Australian schools.

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Table 1:
Major Stressors of Culture and their Implications for Cultural Minorities in Education (Adapted from Eckermann, 1994 p 221)

Stressor	Mechanisms	Families and children's reactions
Mechanistic differences; physical inhibitors	Routine Technology Movement and restraint	Shame/embarrassment Restriction: 'Being stuck' Uncomfortable personal space Dependency/powerlessness
Isolation	Anomic	Withdrawal Fear
Customs	Roles Routines Institutional organisation	Loss of identity Loss of autonomy Alienation
Attitudes/Beliefs	'Teacher knows best' Professional authority	Dependency/Powerlessness Withdrawal
Communication	Non-verbal communication Language/jargon Patterns of speech Rules and conventions Etiquette	Fear/anxiety Withdrawal Not knowing what to do Unfamiliar personal interaction

History and Characteristics of Education for Aboriginal Australians

In traditional societies young Aboriginal people learned as they grew up with an informal learning system, based in the main on the need to know, and supported by a more formal system of initiation. All young people were 'put through the rules' and no society left learning to chance. Education was organic, multi-disciplinary and ensured a complementarity of gender roles (see Nichol, 1988). Learning took place during day to day activities. Aborigines were often fluent in a number of neighboring dialects allowing communication with surrounding groups. Skills were learned by observation, imitation, real life practice and from the oral tradition linking song, site, skin (kinship) and ceremony.

This led to the following characteristics of traditional indigenous education

1. Learning was largely oral and the use of storytelling was important. Sign language also was used.
2. Education was largely informal, except during preparation for initiation when formal, even coercive, and rigorous methods of education were used. Initiates referred to being "tied in" and "broken into" the burba (Nichol, 1988). The more informal methods employed for learning included observation, imitation and casual instruction. Learning occurred through participation in the life of the community. Through these means, a rich cultural heritage was transmitted and children learned the social, economic and religious life of the community, including philosophy, art, music, dance and mythology.
3. Religion permeated every aspect of life. There was no secular education. "All hunting, food-gathering, family life and social life were intimately connected with their religious belief." (Hart, 1970, p 9).
4. Education was closely adapted to the economy. Skills of hunting, gathering and tracking, knowledge of the seasons for fruits, the location of water holes, methods of obtaining water from certain tree roots and plants and so on, constituted important elements of education. It was life related and life inspired.
5. Children learned social responsibilities associated with relationships: the significance of certain individuals in his/her education (father's brothers; father's father's brothers or for girls, mothers and mother's sisters (also referred to as 'mother') and other female relatives

(see Nichol, 1988, and Bell, D. in Edwards, 1998). Knowledge of the kinship system was central to learning.

6. Personal development, within a prescribed pattern, was encouraged. Each young man would be "apprenticed" to an older "master" of ritual, dance, art or song, -sometimes described as a "guardian" a "clever one" or "powerful one". Usually this mentor was a close relative who would hand down the traditional forms of skill and ritual to the learner who in turn, would be entrusted with preserving that part of the culture.
7. Education extended throughout life. Definite stages of wisdom were acknowledged according to age, and status in the community.

AFTER EUROPEAN OCCUPATION

After the European occupation, Aboriginal students were gradually introduced to the European, basically British, form of education. Many efforts were directed to remove the Aboriginal "heathen", "savage" culture and to replace traditional learning with "superior" dominant European knowledge.

Aboriginal children initially were taught a basic, introductory form of Western education that allowed them to function as servants to the European colonists. Advanced studies were thought impossible for the Aborigines to grasp. They were considered to be virtually ineducable (Craven, 1996). The curriculum was one deemed appropriate for the lower orders and one which, by all the evidence now available, failed miserably (Craven, 1996). Notwithstanding the reaction of some conservative elements, particularly in Queensland and Western Australia, today there is greater appreciation by Australian society and government of the worth of all Australian citizens. There is a considerable breakdown of societal barriers to advancement. Aboriginal students have far greater access to education with positive community support through consultative community groups like ATSIC, and government support, for example Koorie Open Door Education (KODE) schools.

However, the system, and many teachers, still carry a hangover of "superior" Western knowledge and methods: a feeling of what is "correct to know" and the methods that have applied in Western classrooms for many years.

Mathematics education is no exception. The traditional Western mathematics classroom has a teacher who explains or demonstrates a law or concept, provides some examples and then sets the students to work on problems of a similar kind. These problems are graded with easy problems first progressing to more difficult ones. Often they are designed to tie in other learning or concepts.

If a justification for the problem is given, it is, "it's good for you" (Noddings, 1994) and very synthetic examples from life are used to try and add relevance. The teachers may "prove the law" with these synthesized problems but those same teachers are still, in reality, the font of wisdom. Modern constructivist inquiry based approaches to mathematics teaching encourage the student to discover the law or concept by experiment with tactile and passive teaching aids (see Mousley, 1992). The teacher appears to have less control of the learning. Students work together cooperatively and use cheap modern calculators and computers to allow real life data to be processed easily.

It is proposed in this paper that these forms of teaching, in particular mathematics teaching, encourage Aboriginal students to have ownership of their learning and to take far more interest in mathematics, general learning and even school attendance.

THE ABORIGINAL CHILD AS A LEARNER

If we are to develop an Aboriginal pedagogy for learning in mathematics then we require a framework for appropriate learning for Aboriginal children. The following characteristics of indigenous pedagogy come predominantly, from Craven (1996):

Holistic Learners

Holistic is interpreted as meaning complete, cooperative, integrated and all encompassing.

- Aboriginal children tend to prefer a holistic or integrated approach to learning (Craven 1996). This reflects the Aboriginal world-view where everything is inter-related and all relationships are important.
- A holistic or integrated learning approach does not compartmentalize learning according to academic disciplines or subsets of apparently unrelated skills. Areas of study are integrated so that learning flows smoothly between content areas, and the inter-relationship between knowledge and skills is apparent.
- Students prefer to observe and discuss a task or topic before working through the components and activity. They learn more effectively if the overall concept and direction of a lesson is outlined, discussed and modelled before specific learning activities are introduced.

Imaginal Learners

Imaginal is understood as relatively unstructured and consists of thoughts, images and experiences of learning and is strongly linked with notions of identity and Aboriginality.

- In Aboriginal societies, learning occurs more frequently in informal, unstructured situations through observation and imitation rather than verbalization.
- Aboriginal cultures are strongly auditory – as shown by their strong oral traditions - but there is little verbal interaction for the deliberate and conscious purpose of teaching and learning. Information is transmitted primarily through observation and involvement.
- For the imaginal learner, images are also a more effective means of regulating classroom behavior. Imaginal learners may have difficulties with purely cognitive operations, and will learn more effectively if concrete examples precede abstract understandings.
- Many Aboriginal children are imaginal and referential learners (Craven, 1996). They rely on visual images, symbols and diagrams to acquire new information and understandings.
- Imaginal learners prefer lessons that are experience-based and sequenced so that a shared experience (film, excursion, role-play, story) is followed by modelling, reflection and self-performance. Teacher-centered instruction (i.e. 'chalk and talk') is not an effective form of instruction for imaginal learners.

Kinaesthetic Learners

This is seen as tactile learning through manipulation and movement within the learning environment.

- Many Aboriginal students are kinaesthetic learners (Craven, 1996). Information is "taken in more easily through their hands and through movement". They like to handle things, to move them around, to also move around themselves (Craven, 1996).
- The kinaesthetic student prefers to learn by observing and then doing. They need learning strategies that allow them to be physically active.

Co-Operative Learners

- Aboriginal cultures place a higher priority on the group than the individual. Learning generally takes place in groups and is a collaborative process. Peer learning is

commonplace. Co-operation is more important than competition or individual achievement. Students who are given time for group discussion and interpretation of instructions and assistance are more likely to be successful.

- Students whose learning pattern is more co-operative than competitive will learn better in small groups which allow for collaborative work with peers. (See Howard, 1994, p 41 in Craven 1996). By contrast, in non-Aboriginal society, instruction is usually given by teachers, followed by a strong emphasis on competition, individual benefit and achievement.

Contextual Learners

- In Aboriginal societies, cultural learning occurs in the specific context to which the learning relates. Children learn hunting techniques during food gathering expeditions; songs and dances during community celebrations; kinship law by interaction with relatives (see Harris, 1977).
- By contrast, Western schools are artificial, man-made environments where the content is removed from, and often has little apparent application to, daily life.
- By contextualising learning, students discover that education is meaningful and relevant to their own lives.

Person-Oriented Learner

- Aboriginal cultures are more person-oriented than information-oriented. Teachers are assessed on the basis of how they relate to children as people rather than by their qualifications or performance as instructors.
- Students who feel personal connection with the teacher will be more co-operative, interested in learning, willing to take risks and attempt new tasks (Craven 1996). Non-Aboriginal teachers who take a personal interest in their students' culture and life outside school will establish a more positive rapport and hence, a more favorable learning environment.
- Teachers can improve student achievement through simple strategies such as acting positively; smiling regularly at the children; welcoming them warmly to class; and building self-esteem through positive reinforcement. Aboriginal children are highly skilled readers of body language!
- Teachers being themselves. Aboriginal children have defined a good teacher as "*Someone who likes us and is fair*" (Craven's emphasis, see Craven 1996).

STRATEGIES THAT CAN BE USED TO MAKE MATHEMATICS LEARNING MORE ACCESSIBLE TO ABORIGINAL STUDENTS

Social Aspects

A classroom and teaching method that takes into account the social implications of Aboriginal culture will help students participate more and consequently learn more actively. The following strategies are recommended:

- Focus on tasks that can be performed as joint projects.
- Introduce peer tutoring.
- Do not insist on direct or immediate answers to questions.
- Avoid public confrontation and reprimands.
- Avoid personal questions.
- Be explicit about the purposes of questions.
- Use small, group questions to reduce 'shaming'.
- Direct questions to the entire class or groups of students rather than the individual.
- Allow students time to respond to questions.
- Ask broad questions rather than specific questions.
- Use peer questioning to evaluate student knowledge.

Environmental Aspects

The learning environment in which the student operates is important to all students and can be used to good effect in helping Aboriginal students.

- Use models, the playground and familiar ground as a teaching resource.
- Students and teacher role playing of various concepts; photography or sketching activities for later literacy or mathematical development.
- Make students responsible for their own learning by using research assignments and self paced learning.
- Allow students to move around the classroom to explore and observe.
- Reorganise the physical learning environment to foster group work.
- Allow students to form their own groups. They often work better with friends and relatives.
- Accept higher levels of 'working noise' in the classroom and use non-verbal strategies to regain attention.
- Organise the classroom furniture with quiet areas and areas for group activities to give students control of their own learning.
- Create a comfortable, relaxed and secure learning environment.

Assessment

Assessment can be very confronting particularly for Aboriginal students so the teacher should aim to use methods with which the students are comfortable.

- Include assessment tasks that allow students to demonstrate their knowledge visually rather than verbally.
- Foster verbalisation of mathematics by using environmental and immersion language techniques and draw on the students' own experiences.
- Assess comprehension by having students re-tell the activity or story using movement and facial expression.
- Use assessment that rewards teamwork.
- Introduce self-assessment of work to avoid alienating students through criticism.

General Teaching

In general teaching, it should not be assumed that students from different cultures have the same requirements and expectations. There is nothing more unequal than the equal provision of education to unequal children. That is, if you wish to perpetuate inequalities then provide the same education for all.

- Allow students to negotiate content, tasks, assignment format, and time required to complete a task.
- Allow students to negotiate classroom housekeeping tasks.
- Effective learning is more important than 'good' behavior or unquestioning obedience; although a measure of success will lead to more positive behavioral outcomes.
- Use unambiguous body language for classroom management.

Mathematics Teaching

It is widely perceived that mathematics is one of the more problematic aspects of Aboriginal education. This need not be the case. The following, if applied to mathematics teaching methodology and content, will play an important role in helping students to gain, as well as to reinforce their mathematical knowledge. Their knowledge will then be both appropriate and relevant to their cultural background and heritage and will also equip them for life and work in the wider Australian society.

- Provide opportunities to learn by doing, with as much community involvement and teaching by Aboriginal people as possible.
- Emphasize 'showing' or modelling rather than explaining.
- Use models and examples to demonstrate concepts, in particular from the local environment and resources.

- Use images, charts, diagrams, models, etc. to convey information and concepts.
- Use multimedia resources including computers and video to demonstrate concepts.
- Incorporate the manipulation of materials into the lessons.
- Use geometric shapes to provide concrete understanding of fractions before proceeding to written work. Demonstrate the meaning of words.

(Adapted from: Craven, 1996; Bucknell, 1995; Harris, Pam (undated); and Patrick-Rolf, 1990.)

CASE STUDY – GARMA MATHS

A program that exemplifies many of the recommendations in this paper is Garma Maths. Garma Maths, or Garma Living Maths, is the name of a mathematical educational program. The Yirrkala Community School in Arnhem Land, Northern Territory, developed it in collaboration with Batchelor College, Darwin, Northern Territory and the University of Melbourne, Victoria.

In the local dialect, the “Garma” is an open meeting place where everyone comes together. Here the different clans participate in a large ceremony and ceremonial negotiation takes place. In its application to the Garma Maths Program, the use of the term “Garma” means the curriculum is created to express and teach the knowledge and methods that the teachers, Aboriginal and non-Aboriginal, from the Yolngu Community, have explored and agreed upon. The Garma Maths Program articulates the formal logical concepts of the Yolngu life and thought. It integrates Yolngu knowledge and the Northern Territory mathematics curriculum. (Adapted from Thornton, 1996 pp 1-7)

Curriculum material in Garma Maths is not based on numbers and symbols repeatedly being introduced, but on how foundation mathematical and logical concepts relate to the Yolngu world and ties this in to Western mathematics, in the form of the Northern Territory Department of Education Mathematics Course of Study.

Position in the kin relationship gives a person certain responsibilities in both learning and teaching. For example, often in Aboriginal communities a father’s brother may be assigned the role of guardian with teaching and supervisory responsibilities. Garma Maths uses this position in the kin relationship and its inherent responsibilities in the presentation and receipt of mathematics knowledge. The presentations in Garma Maths represent knowledge in conventional, formal and abstract forms.

So the Garma Maths Program involves the reactivation of traditional, conceptional and practical thought and the incorporation and adaptation of new ideas. Knowledge is traditionally practiced through ceremonies with dance, song, painting (both inanimate objects and the body) and sculpture. These are used in Garma Maths to motivate, reinforce, embellish and enlarge the learning of mathematics for Yolngu students.

Other mathematical programs which incorporate Aboriginal pedagogical forms in a Western curriculum can be found across Australia (see Howard, 1995; Bucknell 1995; Patrick-Rolf, 1990; Wilson, 1979.).

CONCLUSION

Aboriginal students and their families must not see mathematics as being a difficult, alien subject, as they have too often in the past. It should be seen as a valuable component of what they are learning, a component that is of value to their survival. If the strategies presented in this paper to make mathematics learning more accessible are followed then teachers will be catering for the varying abilities and cultural backgrounds of their Aboriginal students.

Teachers of mathematics to Aboriginal students need to both examine and appreciate the cultural constraints on learning faced by their students within the context of a mainstream curriculum and to build on the large pool of knowledge and pedagogy that the Aboriginal society bequeaths to indigenous students.

Lena Lindenskov (1993) states that "Beliefs about mathematics and school are constructed phenomena, just as knowledge is a constructed phenomena". She points out the importance of knowledge gained outside the school. The authors propose this knowledge could be applied with advantage in teaching mathematics.

As explored in this paper, the astute and caring teacher can apply the cultural differences and knowledge base of the indigenous community as a force to promote learning. While teachers should be potentially aware of the diversity within indigenous society the authors would argue that the strategies recommended have wide application. The authors feel that students and their community need to have positive relationships with teachers; a sense of ownership of knowledge; and to feel that the school is a safe, enjoyable, relevant and productive environment.

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