

Mathematics in Indigenous Contexts: A Case Study

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In 2002, a new K-6 mathematics syllabus was introduced in NSW schools. The Aboriginal Curriculum Unit of the NSW Board of Studies commissioned a research project to investigate appropriate ways in which Aboriginal communities might become involved in the planning and implementation of mathematics curricula based on this new syllabus. Through an intensive process of professional development of teachers and community involvement in two pilot schools, the project has devised some strategies that work in the particular contexts of these schools and have promise for other communities of Aboriginal people and their schools. This paper reports on one of the sites.

The *Mathematics in Indigenous Contexts* project [developed through the New South Wales Board of Studies] aims to enhance the mathematics learning outcomes of Aboriginal students through the professional development of teachers and the collaboration of the parents of Aboriginal students with teachers in the development of contextually based mathematics units. Family involvement in Aboriginal children's learning in general and mathematics learning in particular is reported to be of critical importance in that it "provides students with significant positive social capital ... heightens parental aspirations for their child's future as well as providing a focus for their expectations on the education system to provide the quality of education necessary to assist Aboriginal students achieve these aspirations" (Board of Studies NSW, 2002a, p. 4). Further the contextualisation of mathematics learning experiences is viewed as a means of presenting mathematics in a recognisable way building on the Aboriginal students' out of school mathematical experiences. Such contextualised mathematics experiences enable Aboriginal students to develop their mathematical language and strengthen their skills and knowledge in Western mathematics (Frigo, 1999). Foundational to the involvement of parents of Aboriginal children in mathematics curriculum development and the contextualisation of mathematics activities is increased teacher understanding and appreciation of different pedagogical models that aim to build mathematics confidence and competence of Aboriginal students. Thus, three key elements of this mathematics project are:

- the collaborative involvement of Aboriginal parents in curriculum development;
- the contextualisation of mathematics units of work; and
- the professional development of teachers.

Literature Review

Teacher Professional Development Issues

There are significant reforms in mathematics which impact upon the professional learnings of teachers of mathematics (NSW Department of Education and Training, 2002; National Council of Teachers of Mathematics, 2000). As well, there is a growing awareness of issues affecting the mathematical learning of students from varying cultural backgrounds and particularly those affecting Australian Aboriginal students (Frigo, 1999; Frigo & Simpson, 2001; Howard, 2001). Purposeful professional development activities are required for teachers of Aboriginal students if mathematics classroom pedagogical reforms which appreciate the social and cultural contexts of mathematics education are to occur (Atweh, Forgasz & Nebres, 2001; Borko & Puttman, 1998).

On-going professional learning is critically linked to survival within the teaching profession. Table 1 identifies key principles of effective teacher professional development identified through a meta-analysis of relevant literature (Hawley & Valli, 1999, p. 38).

Table 1
Design Principles for Best Practice

Elements in Good Practice	Good practice is therefore ...
1. Goals and student performance	Driven fundamentally by analyses of the differences between the goals and standards of student learning, and actual student performance.
2. Teacher involvement	Involves learners (ie teachers) in the identification of their learning needs and, when possible, the development of the learning opportunity and /or process to be used.
3. School-based	Is primarily school-based and integral to school operations.
4. Collaborative problem solving	Provides learning opportunities that relate to the individual needs but for the most part are organized around collaborative problem solving.
5. Continuous and supported	Is continuous and on-going, involving follow-up and support for further learning, including support from sources external to the school.
6. Information rich	Incorporate evaluation of multiple sources of information on outcomes for students and processes involved in implementing lessons learned through professional development.
7. Theoretical understanding	Provides opportunities to develop theoretical understanding of the knowledge and skills to be learned.
8. Part of a comprehensive change process	Is integrated with a comprehensive change process that deals with the full range of impediments to and facilitators of student learning.

For beginning teachers the utilisation of a mentoring process within professional development programs that support these principles is recommended (Sparrow & Frid,

2002). It is also recognized that for most teachers “the focus of useful professional development is the teacher’s own classroom” (Dwyer, 2002, p. 92). The mentoring process provides the opportunity for less experienced teachers to team with those of more experience within a defined framework. The framework can be a formally structured program supported and resourced through strong organizational commitment, the provision of time, careful planning, adequate preparation of mentor and mentee, voluntary participation, professional and ethical relationships and a format that identifies goals, processes and outcomes (Long, 2002). The implementation of these principles into teacher professional learning opportunities may still be quite limited (D’Orsa, 2002).

Aboriginal Parent Involvement in Developing Mathematics Curriculum

Many mathematics classrooms comprise children and teachers from varying cultural backgrounds. In these contexts, there are a number of social issues which influence learning including culture, racism, bias, and prejudice (Partington, 1998). Some of these issues can be alleviated through participation of parents and other community members in their children’s schooling. “The participation of people from the local Aboriginal community allows the curriculum to be explored at a local level, making studies more relevant to students” (Board of Studies NSW, 2001, p. 4).

In Australia, mathematics curricula have generally not emphasised the concerns and contextual issues influencing Aboriginal children’s learning. Aboriginal parents hold beliefs towards mathematics which impact upon their children’s learning of mathematics and teachers need to consider these (Howard, 2001). As teachers introduce new pedagogical strategies they may be adding to a mismatch between the expectations of the school and the home. A degree of mismatch in beliefs amongst the students and the teacher may well occur in any classroom, but it can be exacerbated when there is a diversity of cultural backgrounds (Cataldi & Partington, 1998). Such mismatch may become a challenge for Aboriginal children and may lead to confusion and anxiety in the classroom (Ngarritjan-Kessaris, 1994).

The current pedagogy in mathematics education emphasises students’ thinking for themselves, constructing mathematical knowledge, using mathematical language, working in groups and problem solving. It is important that “the family comes to understand the value of different approaches to learning and the implications of this in what children do in the mathematics lessons” (Dawe, 1991, p. 50). If there is a mismatch amongst parents, children and teachers in the set of beliefs about the learning of mathematics and the interactions within the mathematics classroom, mathematics anxiety may occur.

The issues of student confusion and anxiety, and a potential mismatch between home and school expectations about mathematics learning, particularly for Aboriginal children and parents make it essential to seek the espoused beliefs of the parents of Aboriginal children. The discussion of such beliefs will assist teachers, children and parents in collaborating for more appropriate mathematics curriculum and teaching strategies to enhance the mathematical learning outcomes of Aboriginal children (Howard, 2001).

“Mathematics in Indigenous Contexts”: Background, Aims and Outcomes

The primary foci of the project were to improve the understanding of teachers regarding the numeracy learning needs of Aboriginal students, to develop innovative curriculum using contextual mathematical concepts and to deeply engage Aboriginal parents in the process of learning. A central theme to the project was to look at the processes of real engagement between teachers and Aboriginal parents in the development, implementation and evaluation of school developed mathematics curriculum. Improved relationships were seen to have a significant role in community capacity building, by challenging both, the often held negative view of Aboriginal students about schooling and the views held by schools about Aboriginal students’ capacity and willingness to learn and engage in schooling.

There have been three phases to date in the *Mathematics in Indigenous Contexts* project. Phases 1 and 2 analysed the research literature related to resource and teaching strategies to support Aboriginal students’ numeracy learning (Frigo, 1999) and resultant implications for mathematics syllabi (Frigo & Simpson, 2001). Phase 3 began with the initial planning of a *K-6 Mathematics in Indigenous Contexts* project. It was decided that schools with the following characteristics would be chosen for the project:

- contain a significant number of Aboriginal students;
- staff open to developing partnerships with parents in the planning and implementation of the mathematics curriculum;
- teachers prepared to evaluate their current mathematics teaching practices;
- staff open to an in-depth investigation of current mathematics teaching practices and structures;
- staff prepared to implement the new *K-6 Mathematics Syllabus* (Board of Studies NSW, 2002b);
- staff open to direct involvement of mentors and NSW Board of Studies staff.

Following the initial planning, two school sites, Newmarket and Anderson Public Schools [pseudonyms] were chosen. Newmarket P.S. has a student population of 740, 83 of whom were Aboriginal, 32 full-time teachers plus additional staffing entitlements and is located in the western suburbs of Sydney. The school has one Aboriginal Education Assistant (AEA) and an active Aboriginal Student Support Parent Association (ASSPA). None of the teaching staff was Aboriginal. Anderson P. S. has a student population of 25, all but two of whom were Aboriginal, two full-time teachers, including the Aboriginal principal, plus some additional fractional staff and is located in north-west New South Wales. In both schools, learning networks of teachers, parents and mentors were established to facilitate the development and implementation of contextual mathematics units of work.

Two levels of mentorship were provided to the staff. Peer mentors selected for their knowledge and expertise in K-6 mathematics teaching were linked to the teachers in the schools and provided ongoing support as critical friends. A second level of mentor support was provided by a university research team that assisted the schools, teachers, Aboriginal communities, NSW Board of Studies Aboriginal Curriculum Unit staff and the peer mentors. During Phase 3 research data were collected to provide a tracking of the progress of the project. This paper reports on data collected at Newmarket Public School.

Methodology and Data Collection

A number of innovative research strategies were utilised during the data collection. All participants were asked to keep a learning journal of their participation. The NSW Board of Studies purchased digital video cameras for each school to record project activities, including staff meetings, teacher planning meetings, mentor-teacher planning days, ASSPA meetings and in class student activity. Some still photographs of various elements of the project were collected together with student work samples of the developed mathematics units of work. Two Sharing Days were held across the project where school staff and community members came together to inform and share their learnings with one other. For this paper, teacher journals (Trish, Susan), AEA comments (Terri), Aboriginal community meetings (Carol, Michelle, Tony, Belinda, Annie) and summary transcripts of teacher-mentor sessions were analysed using a grounded theory approach (Cohen, Manion, & Morrison, 2000). In this way, categories of response were developed which directed the data analysis.

Discussion

Teacher professional development issues

The project involved three non-Aboriginal teachers from Stage 2, Years 3 and 4. At Newmarket PS the teachers felt that “they worked well as a team” [Trish, 10.4.02]. They acknowledged that this was “a huge project” [Trish, 27.3.02] and that the mentors were able to help them “make more sense of the project’s direction” [Trish, 8.4.02]. The coming together of teachers and mentors enabled the teachers to “walk away a lot clearer” [Susan, 12.4.02]. This continued to be the case throughout the project. In all cases the teachers decided to work with both mentors at the school because “communication was very important and it could be lost in the transition from one to another” [Susan, 12.4.02]. One teacher decided to use a local park as the focus of her mathematics unit and the mentors provided a stimulus for initial ideas for the emerging mathematics unit.

It’s funny you know, I’ve been to Nurragingy so many times and I’ve just enjoyed its natural beauty. Never have I really studied or looked at the mathematics present there. [Susan, 28.4.02]

The teachers found that working with the mentors allowed them to reflect upon their mathematics pedagogy. The meeting with the mentors facilitated a greater analysis of the *Basic Skills Test* results.

I became very interested in the sorts of questions the children had difficulty with, as well as the strands. I collected this data and was able to graph the results. This was excellent pre-assessment that made it clear to me what areas of space I should focus on. I have decided to incorporate measurement in my lessons as well as it links closely with Space. From the BST results I discovered that length was an area of need. [Trish, 17.5.02]

The Aboriginal focus of the mathematics units was explained in one teacher’s journal, we had to keep our project within the cultural awareness of Aboriginals. Meaning our units needed to be based about and around Aboriginals. For me, this meant what I needed to research what Aboriginals did in their recreational time. I also needed to respect their land and identity, connecting it to the community. [Susan, 1 5 02]

The teachers who had begun working well as a team began to develop interpersonal tensions as a result of their work on their individual units of work. On one particular

mentoring visit, the issue of competition in the development of the units began to emerge and there was a sense of hostility amongst the teachers. As a result, “The day was productive, however, not as productive as past planning days with the mentors” [Susan, 12 6 02]. There was a need for a debriefing amongst the teachers themselves as to the workload pressures and the issue of competition being generated.

The Newmarket teachers presented their units of work to their peers at a local professional development course. Susan journalled [25 7 02].

We were given a blank page and told to write a unit. At first I felt used when the project began, however after the presentation I was on such a high that you could of pushed me over with a feather. To believe we did it all by ourselves, with help from our mentors of course. What a buzz! What an accomplishment!

All Newmarket teachers spoke with the Aboriginal Education Assistant (AEA) about their units of work, “I discussed the cultural behaviour of local Aboriginals” [Susan, 16 5 02]. In reality, the AEA (Terri) became a third level of mentorship to the teachers. She acted as the link between the project, the Stage 2 teachers and the Aboriginal community. She took on the role of contacting local artists and having them help the teachers develop their units of work, particularly the Space unit. The project brought the teachers together with the Aboriginal community through the Aboriginal Student Support Parent Association (ASSPA) committee.

We were all present at the ASSPA meeting. I had never attended one before. Very informal, where everyone has a chance to speak. We stressed to the parents that we needed their support. I felt that by attending we had gained their support [Trish, 1 5 02].

The interest by the ASSPA people was overwhelming and I walked away from it feeling very confident and appreciated the community support we were offered [Susan, 1 5 02].

The ASSPA committee was a knowledgeable information source to the teachers, particularly with regard to investigation and involvement, “I know that the male Aboriginal students in my class would respond better if they were involved” [Susan, 1 5 02]. The teachers became involved in NAIDOC week deciding on a poster presentation of “How we use maths in Everyday Life”. The poster displayed “outcomes in laymen terms with examples of maths covering the three strands” [Trish, 1.5.02]. The mathematics workshops developed by the teachers were held on July 2 with the aboriginal students and adults all commenting on how much they had enjoyed them and “how unusual it was to have mathematics as part of the celebrations” [Susan, 2 7 02].

Part B: Aboriginal Parent Involvement in Developing Mathematics Curriculum

During the project three ASSPA meetings at Newmarket P. S. [May 1; May 29; August 28] focused their discussion on the mathematical learning issues of their children. The ASSPA committee meetings were a means of connecting and engaging the Aboriginal community in mathematics curriculum development. Already, it has been noted that for the teachers involved in the project this was the first occasion they had attended any ASSPA meeting. The meetings provided pertinent cultural comments from Aboriginal parents about their beliefs on how their children’s mathematical learning could be enhanced. “Koori kids feel that teachers will blame them if they ask questions. They feel shamed. They won’t put their hands up in maths” [Terri, 1.5.03]. These beliefs informed and assisted the teachers in

the construction of the mathematics units of work. “Our perceptions as adults about what the kids are saying in maths, is different to the perceptions of the kids in what they are doing” [Terri, 1.5.02]. Mathematics and the units of work were talked about informally at both meetings. The mathematics project was placed into the overall context of Aboriginal activities about the school for it was just one thing happening in the lives and the community of the Aboriginal people.

During 2001, Newmarket had been involved in an in-school literacy tutoring project. In order to support the mathematics project, ASSPA decided that numeracy was to be a parallel focus for 2002. “You tell me when the maths lessons are in Year 4 and I will organise the tutors who want to work with the children” [Carol, 29.5.02].

The ASSPA committee was a means by which information, access to resources, ideas on formulating and contextualising the mathematics units [visiting Nurranginy; painting Aboriginal murals along the pathways; NAIDOC poster presentation] and Aboriginal children’s learning issues were expressed to the teachers. “Teachers need to start to think about different ways of thinking in mathematics” [Tony, 1.5.02]. “Teachers keep teaching the same thing over and over it becomes jargon to our kids. You [teachers] get so use to talking about what you are teaching that it becomes alien to the kids” [Michelle, 1.5.02]. The committee developed the cultural significance involved in the mathematics activities being generated. It also provided a forum where racism, conflict and stereotypic views about Aboriginal and non-Aboriginal collaboration was broken down.

Koori parents can make a difference through knowing what is happening in mathematics and being involved in mathematics curriculum development. They viewed their involvement in curriculum development as “learning with the kids” [Michelle, 1.5.02]. It was critical for the teachers to attend the ASSPA committee meetings to establish and consolidate relationships, to listen to the parents, to share ideas and to bring joint ownership to the mathematics project. “There are not all the answers. It’s a journey where the questions are raised and answers looked for” [Annie, 1.5.02]. The Aboriginal parents want “our kids to be as good as the other kids. Nothing so different with Koori kids except a long history of not succeeding at school” [Belinda, 1.5.02].

At the last reported ASSPA committee one teacher commented, “We can have great curriculum units but it is in the learning and teaching that you will see the success of the units” [Susan, 28.8.02]. The Aboriginal community gained a greater awareness of what was happening in the mathematics classes, they informed the mathematics curriculum, had conversations with teachers about mathematics learning and teaching, began to share the same mathematics language and gained a further appreciation of the school system.

Conclusion

The *Mathematics in Indigenous Contexts* project has shown that the process of adopting the ‘fellow worker’ as mentor (Sparrow & Frid, 2002) model for teacher professional development proved successful. The model provided support to beginning teachers in articulating pedagogical issues that they were grappling with, assisted in the development and construction of the mathematics units of work, calmed tensions amongst the group and provided support in recognizing the mathematics potential available in local sites. The positive interactions and benefits gained from working with the mentors enabled

teachers to develop awareness of their own feelings towards mathematics and knowledge of their own pedagogy.

The fact that Aboriginal educators are appointed to a school with Aboriginal children identifies that there are specific educational, social and cultural influences affecting their learning. This mathematics project highlighted the mentoring role that an AEA can provide to teachers. It also showed the critical nature of the AEA's role in linking teachers and the Aboriginal community in local school-based mathematics curriculum development. The collaborative nature of this project enhanced the students' learning of mathematics by providing opportunities for relevant mathematics curriculum activities and in creating the opportunities for mathematical conversations between teachers and Aboriginal parents.

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