
CULTURALLY RESPONSIVE MATHEMATICS PEDAGOGY: A BRIDGE TOO FAR?

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Abstract

The Swan Valley Cluster of Schools for the Make it Count project identified the professional learning of teachers as a key factor in improving the numeracy outcomes of urban Indigenous children. Two mentor teachers were assigned to support cluster teachers in planning and teaching mathematics during 2011. This paper reports on the initiative and it focuses on the teachers' knowledge, development, and use of Culturally Responsive Mathematics Pedagogy as part of the development of a general awareness of mathematics, pedagogy, and children. For most teachers identifying the mathematics content to be taught and aspects of new pedagogies dominated their thinking. This in turn left no room at this time for many of them to consider implementing pedagogical principles relating to their learners' socio-cultural background. In order to implement culturally responsive mathematics pedagogies teachers need to be aware of and sensitive to the mathematical needs as well as the socio-cultural contributions of their children.

Background

A major focus in 2011 for the Swan Valley Cluster of schools in the Swan Valley of Western Australia, as part of the national *Make it Count* project, was in the broad area of Curriculum and Pedagogy (Cluster Plan focus #1). *Make it Count* is a national initiative of the Australian Association of Mathematics Teachers aimed at 'closing the gap' in mathematics achievement by many urban Indigenous children. The Cluster plan for 2011 identified supporting teachers' professional learning as one way to enhance, among other things, the Culturally Responsive Mathematics Pedagogy (CRMP) of teachers working with children of Aboriginal heritage in an urban setting. This broadening of pedagogical knowledge was hypothesised to improve the mathematics learning of the Indigenous children within their classes. Two experienced teachers, trained as part of the First Steps in Mathematics (FSiM), and also acknowledged to be 'culturally sensitive' were identified to act as support mentors to lead this initiative for the Cluster.

The main objective for this research project was to identify, develop, clarify, and evaluate mathematics teaching strategies that may enhance the mathematics achievement of urban Indigenous children. This main objective may be broken into related sub sections:

- To evaluate the effectiveness in terms of enhanced mathematical content knowledge (MCK) and pedagogical content knowledge (PCK), including knowledge of children, of the proposed model of professional learning with cluster teachers; and
- To clarify and develop teaching strategies that could be termed Culturally Responsive Mathematics Pedagogies.

This paper will discuss issues and findings relating to the second section. An earlier paper (Sparrow & Hurst, 2012) reported findings relevant to the first section.

Professional learning

The Professional Learning model employed in this project was based on the essential elements of professional development (Sparrow, 2000) in that it was situated within each teacher's working context, addressed mathematics teaching issues personal to the teachers, engaged teachers in reflection on practice, took place gradually over time, and empowered teachers to make decisions related to their children with a focus on urban Indigenous children, their teaching, and their classrooms (Sparrow, 2000). In this way teachers identified and met their own needs for Professional Learning. The mentor

teacher was used as a human resource to support and inform the identified needs. As Easen (1985) noted a number of years ago when he wrote:

> *You cannot change other people, nor can they change you; people can only change themselves. The best anyone can do is to provide a structure, which helps others to change, if that is what they want to do (p. 71).*

A focus of the mentor role was one of teacher empowerment so that learning about teaching mathematics could be sustained and developed after the project was completed. A more detailed description of the professional learning and mentor models can be found in Sparrow, (2000), and Sparrow and Frid (2002). There was also to be a specific focus on ways in which teachers might teach in order to address the identified needs of the urban Indigenous children within the class — the idea of Culturally Responsive Mathematics Pedagogy.

Culturally Responsive Mathematics Pedagogy:

Most teachers within the school systems of Western Australia do not come from an Indigenous heritage and often do not fully appreciate that Indigenous children in many cases are subject to different sets of family and community expectations. Perso (2003) suggested that in order to '… demonstrate behaviours and attitudes that engage, build and maintain relationships with Aboriginal and Torres Strait Islander peoples' (p.1) teachers must develop 'cultural competence'. Sullivan (2009) also noted that students' prior knowledge and background must be acknowledged and built upon and that teachers need to look at children not only from a 'mathematical viewpoint' but also consider their complete socio-cultural background. In this way their particular strengths can be built on in ways that enable them to maintain their cultural connections as well as develop their ability in mathematics. A further issue noted was the need to alert teachers to question personal assumptions, the use of stereotypes, and the dangers of making assumptions and general statements about children as individuals.

Cultural competence may be viewed as a continuum with individuals (teachers) at various levels of awareness, knowledge and skills. Bennett (1993) outlined the *Developmental Model of Intercultural Sensitivity:*

Denial — defence — minimisation — acceptance — adaptation — integration.

Figure 1: Bennett's Developmental Model of Intercultural Sensitivity.

As individuals move from the left-hand-side to the right they develop a more complex and sophisticated understanding of culture (their own and that of others). This is increasingly important for teachers as they attempt to meet the varying needs of the children in their classes.

Wells (2000) also noted the need for changes in behaviour of people, especially teachers, as they work with children from different cultural backgrounds. She developed (See Figure 2) a model of attitudinal and behavioural change related to Cultural Competence:

Incompetence — knowledge — awareness — sensitivity — competence — proficiency

Figure 2: Wells' Model of Cultural Competency.

The development of Culturally Responsive Mathematics Pedagogy (CRMP) is a major focus of the national *Make it Count* (MIC) project and also a focus of the Curriculum and Pedagogy aspect of the Swan Valley Cluster 2011 plan. CRMP is an area that is being developed, explored, and clarified by members of the MIC national project. As yet no definitive criteria for CRMP have been established. There are, however recommendations for working in mathematics teaching and learning with Indigenous learners that stem from research projects, for example the *Maths in the Kimberley* project

(Jorgensen, Grootenboer, Sullivan & Niesche, 2010), and other documents, for example *What works* (Ainsworth & McRae, 2006). It is acknowledged that some of the suggested strategies have been used with Aboriginal children in remote locations, while others are recommendations relating to practices in mathematics teaching in the general population. None are specifically noted for urban Aboriginal children.

Suggested strategies for working with Indigenous children in mathematics:

- Use materials to support understanding in mathematics learning;
- Develop mathematical understanding beyond the use of materials;
- Instigate small group work so that children can explore, and discuss mathematical ideas.
- (This is followed by individual assimilation of the concept);
- Model general ways to work mathematically using 'think aloud' protocols;
- Use children's talk, explanation, and teacher questioning to develop mathematics literacy;
- Use the class AIEO or EA as an informed support teacher;
- Plan collaboratively to include innovative and appropriate teaching strategies;
- Place an emphasis on verbal rather than written instructions;
- Use appropriate game playing to introduce and consolidate learning;
- Use more open learning tasks;
- Have high expectations of the children in mathematics learning;
- Be responsive to the particular social and cultural contexts of the children;
- Build mathematical learning from what children already know;
- Explicitly demonstrate and explain relationships in mathematical learning;
- Work towards conceptual development and not concentrate on mathematical procedures;
- Provide a clearly articulated mathematics learning focus for each lesson.

In slightly more general terms, Kilpatrick, Swafford and Findell (2001) noted that all children are best served when attention is given to:

- Building learning on what children already know; and
- Designing teaching to use what children bring to the classroom.

Further to this, Yunkaporta (2011) suggested that 'culturally responsive teaching involves grounding learning in students' own experience and knowledge of people and place, and ensuring the school and classroom environment reflect these'. (p. 2) He suggested that as teachers' understanding of CRMP grows they 'tailor their teaching practices to respond to the diverse lived realities of all their students'. (P. 2)

Methodology

The project was set within a broad qualitative paradigm and used data gathering techniques of semi-structured participant interviews, and mentor informal observations and notes on teachers. Interview data were transcribed from the audio recordings of the interviews and, using grounded theory, emerging themes were noted.

The participants were two mentor teachers from Valley View Primary School (VV), six classroom teachers from Velo Primary School (V), ten classroom teachers from Valley View Primary School, and the principal from Valley View. Valley View Primary School has an enrolment of 422 children, of whom 61 are of Indigenous heritage. Most of these children are clustered into 3 classes within the school. Teachers identified by the Principal as 'culturally sensitive' teach the cluster classes. These classes contain a supportive network with Aboriginal and Islander Education Officers (AIEO) and Education Assistant (EA) presence and a focus on the use of familiar oral language by the Aboriginal children as part of their mathematics learning. The remainder is within age appropriate classes in the school. Velo Primary School has an enrolled population of 136 children, all of Indigenous descent. Both schools are within the State system of the Department of Education of Western Australia and attract children from the large urban/semi-rural area of Midland and the Swan Valley.

Research question:

What are the characteristics of Culturally Responsive Mathematics Pedagogies pertaining to urban Indigenous children in Western Australia?

Results

This section of the paper will outline the results obtained from the interviews, and mentor notes in relation to participant teachers' practices relating to Culturally Responsive Mathematics Pedagogy. It will consider the results under the following headings to highlight factors relating to CRMP: knowledge of Aboriginal culture, knowledge of Aboriginal learners, knowledge of CRMP, and the impact of these practices on the mathematics learning of urban Aboriginal children in the school. Teachers will be identified by their school (VV) or (V) and an identifying number, for example (VV3).

Knowledge of Aboriginal culture

The local Aboriginal people of the South West of Australia are the Nyoongars, and the traditional custodians of the Perth and Swan Valley region, in particular, are the Whadjuk Nyoongars. Children at the cluster schools originate mainly from this cultural group. In addition, there are children from Indigenous groups from other regions of Western Australia who have moved into the area either recently or have become established as part of a general intrastate movement.

Interview data suggested that teachers in the two schools have a broad, non-Indigenous view and general awareness of Aboriginal culture. Two of the teachers from Velo Primary, however, had worked in remote schools in Western Australia and were able to relate more specifically to the cultural traditions of those people. The remainder of the teachers had taught within the broader Perth Metropolitan region in which they had limited experience of Aboriginal culture. There was no acknowledgement by teachers within the interview data of specific cultural practices of the local Aboriginal community whose children attended the schools.

Knowledge of Aboriginal learners

As the project developed and the visits of the mentor teachers grew in number the teachers became more aware and informed of the mathematical achievements and mathematical learning needs of the children, both Aboriginal and non-Aboriginal, in their classes. The use by teachers of small, focussed, diagnostic tests, as suggested by the mentors, provided more detailed information about the children's achievements in specific content areas of mathematics. From this information, teachers were better able to match the teaching content to the identified mathematical needs of the children (See Sparrow & Hurst, 2012).

Most of the teachers spoke of their general lack of knowledge of the specific Indigenous cultural background of the children attending the school and their class in particular. Some saw the idea of background socio-cultural knowledge as not important or had a view that suggested that there was no influence from Indigenous cultural practices of relevance to mathematical learning or teaching style. One teacher noted that the children were 'Westernised, with not a lot of cultural things coming from home.'(VV2) Another teacher suggested that the children were 'not so centred around *country* — they were more street savvy.' (VV3) 'These are urban children. Their world is Foxtel and shopping centres.' (V 6) One of the teachers of younger children suggested that she thought the children who moved into the suburb surrounding the school from more remote rural areas 'have more culture.' (V1)

Teachers, especially those from the early years of school, were aware of social deprivation factors impacting the children. They spoke of this in terms of social factors rather than factors of the children's Aboriginal background. For example, teacher (VV1) was able to outline the range of family backgrounds for the Aboriginal children in her class — one lived with her auntie, two were with their grandmothers, one was with non-Indigenous foster parents as both her biological parents were in prison, and one was with his mother and step-father.

Much of the description highlighted a deficit view of the children. Teachers noted the 'poor language',

and the limited social skills of the children within the classroom setting. One teacher of middle primary children suggested that for her children 'number was not there.' (V4) For some of the teachers it was 'hard to say what they bring to school' and hence in some classrooms there was little or no acknowledgement of the lived realities of the children and their potential personal contributions to the classroom.

Culturally responsive mathematics pedagogy

The teaching responses from the teachers at the two schools fell generally into two groups — those showing awareness of their Aboriginal learners, and those who treated everyone in the same way. Some of the teachers from the first group, designated 'culturally sensitive', had been asked to teach classes with groupings of Aboriginal children at Valley View School. The other teachers in this group, from Velo Primary, had experienced working with Aboriginal children in rural and remote schools.

In the other group some of the teachers stated that they treated all the children in the same way and did not pay attention to the cultural background of the children. For example, two of the teachers of the younger children stated that they applied early childhood teaching principles that were effective with any children. 'I do not teach them specifically as Aboriginal children — I teach them as early childhood students.' (V2)

Generally, those teachers in the first group made specific mention of the importance of building a positive and strong relationship with the Aboriginal children. In fact, one mentor teacher (VV3) spoke of spending much of the first month of the new school year on establishing good relationships and developing respect for both the teacher and the children. Embedded in this relationship was a feeling of trust. Once this was established, she suggested, 'children will try and you can state your expectations and say when things are not good enough.' (VV3) The teachers also spoke of trying hard to avoid setting situations that might involve children failing or being 'shamed' in front of the class. Two of the teachers noted efforts to build confidence in children and to make them feel comfortable so they did not 'hide' in situations involving mathematics.

Many of the teachers in the first group highlighted the use of contexts that they suggested were commonly known to children as a way to engage the children in mathematics. In this way they could also show the purpose of the activity. A number of these teachers mentioned using money, as the children were interested in money contexts. Mentor teacher (VV5) tried to work where possible within the 'personal lived experiences of the children'. She spoke of using food and cooking as the context for mathematical learning. She used recipes with older primary children who then worked out the number and amount of required ingredients. This was followed by a visit to the local Coles Supermarket to purchase the materials before taking them back to school to be measured and used in whatever was being cooked for that day. She noted better engagement and attendance by the children on 'cooking days'.

This group of teachers also mentioned game playing and using cards and dice. They spoke of this as bringing into the school the context of the children's home-life. The use of dice and cards as well as other physical materials was a large focus of the work with the mentors and was taken up more readily by this group of teachers. The teachers also noted that this was a time when many of the children used a more informal way of talking with their peers. One teacher at Valley View made specific reference to the use of informal English during 'Yarning time' that often preceded a new piece of work.

Teachers in the second group reported that sometimes they used contexts for talking about mathematics via a children's storybook. The books used were of a general nature and not with a specific Aboriginal focus. Teachers in the early years of schooling noted the use of incidental opportunities, such as fruit time to develop language in context. This, however, was not always with a mathematical focus. In fact, the second group of teachers generally added more variety to their teaching style as a direct result of working with the mentor teachers. They allowed children to work away from the textbook, workbook, or Black Line Master sheet.

All teachers mentioned their emphasis of 'building the language'. They worked with the children on the words and vocabulary of the particular mathematical topic they were teaching. There was no evidence of children being required to describe or explain what they had done or learned in mathematics.

Impact on mathematics learning of Indigenous children

The reporting of results here will only focus on the reactions of the children and the perceptions of the teachers involved. Specific data from NAPLAN and other internal assessments will be reported in other ways. All teachers at Velo Primary and those from the classes with the grouped Aboriginal children at Valley View all reported improvements and a new enthusiasm for mathematics by both the children and the teachers. 'The kids love it — they have picked up on the teacher's enthusiasm.' (V2) They noted better attendance by Aboriginal children, 'especially on cooking day' (VV5) as well as enhanced enjoyment and engagement 'from the use of games.' (V5) The use of materials added to the engagement of children with new mathematics content as it meant that the children 'did not sit at the same thing for a long time.' (V3)

'Teachers' better understanding of mathematics content lifts expectation of children and offers more appropriate challenges.' (VV5) Not only were the teachers beginning to understand so were the older children. They were 'using mental strategies rather than working through the standard algorithm in their head. They are front loading and partitioning.' (VV8) Furthermore, children in some classes at Valley View were beginning to 'write and talk a lot more.' (VV8)

Discussion and Conclusions

The professional development program with the use of mentors working in a one-to-one basis with teachers at Velo Primary and at Valley View Primary schools has developed the awareness of the teachers involved in three specific ways — their knowledge of mathematics, their knowledge of mathematics pedagogy, and their knowledge of learners. An earlier paper (Sparrow & Hurst, 2012) reported the developments in each of these areas and suggested that the majority of teachers had developed on the continuum (Table 1) to approximately the third level. Some of the teachers had moved all the way from the first level. Evidence presented in the previous section supports the notion that for most of the teachers the final section, where they had to consider the contributions, needs and achievements of the children, was 'a bridge too far' at this time of their development. In many cases they had made huge personal developments in knowledge of mathematics content and teaching techniques. These changes and developing awareness had dominated the teachers' thinking and the additional burden of accounting for the specific mathematical and background knowledge of the children was something that they could not deal with at this time.

Table 1:
Continua of awareness of teaching mathematics to Indigenous Children.

Knowledge of Mathematics	Unplanned, intermittent teaching	Broad coverage of syllabus statements	Analysis of the finer details of the statements	Matching of detail to children's needs
	Worksheet, textbook, and testing	Some variety in teaching style	A wide range of teaching styles and tasks for children	Matching teaching style to identified needs of children (including Indigenous ways of learning)
Knowledge of learners	Unaware of learners	Aware of learners and their mathematics knowledge	Responsive to learners' needs in general	Responsive to the needs (including cultural) of urban Indigenous children.

Some of the teachers were more aware of the background and cultural influences that impacted their children and began to match the mathematics learning and their teaching style to the needs of the children. These generally were the teachers who were 'culturally sensitive' and were progressing towards the right-hand sections of Wells' model of attitudinal and behavioural change.

A possible key to the development of better mathematical learning by Indigenous children seems to come from supporting classroom teachers on their journeys of awareness. As they become more aware of the detail of the mathematics content that the syllabus requires they grow in confidence and are able to plan more appropriate lessons. As they become more aware of the mathematical strengths and gaps of their children they are better able to match children's needs with their mathematical tasks and lesson purpose. As they become aware of different ways to teach the mathematical knowledge they are better prepared to add variety to their teaching style and to the tasks they set for children. As they become more aware of the background of their children and the experiences and cultural knowledge the children bring to school they are better able to match their teaching to the children. They are able to employ 'responsive mathematical pedagogies'.

The following were aspects of teaching (CRMP) that appeared to work more effectively with the urban Aboriginal children in mathematics learning:

- Building respectful relationships;
- Avoiding situations of failing and shaming;
- Having a clearly defined mathematical learning purpose for the lesson;
- Using a variety of teaching methods including the use of games;
- Using the lived experiences of children as contexts for mathematics learning.

The aspects of teaching that seemed to work best with Indigenous children were those adopted generally by teachers who had a good knowledge of the mathematics they were teaching, a good knowledge of interesting ways in which to teach mathematics, and a good knowledge of the mathematical achievements and needs of their children. This is not new. Mathematics education writers, such as Willis and Tracey (2005) in the explanation of the professional judgment model from First Steps in Mathematics have expounded this earlier. The extra dimension of knowing some of the specific and local background of the children from a social and cultural perspective allowed the teachers to be aware and therefore sensitive to these aspects of the children's lives. They were able to work actively to avoid failing and shaming situations. They were able to use the lived experiences of the children as contexts for mathematics learning. Such teachers were becoming, in Yunkaporta's term, 'culturally responsive teachers' by paying attention to not only the mathematical background of the children but also their complete socio-cultural background. They did not treat all children in the same way in a naïve effort for equality.

Teacher (VV2) suggested that she and other teachers 'cannot be culturally responsive if (she was) not culturally aware'. In line with Wells' model, teachers need to move from no awareness of their children's cultural and social background to one of specific awareness. In this way awareness can develop into sensitivity and then into appropriate action within the mathematics classroom. Teachers within the schools spoke of not knowing much about their children's backgrounds and what experiences they brought to school, others worked with broad generalisations and stereotypes, whereas some only saw children in terms of what they did not know. Awareness can grow where schools and teachers adopt specific practices to seek out and understand the social and cultural backgrounds of their children and also allow their communities to bring their knowledge to the mathematics curriculum and practices within the school. First and foremost teachers need to develop an extensive range of mathematics pedagogies and then know which pedagogies work best for any children. If they are also culturally sensitive they will be able to make appropriate pedagogical decisions for urban Indigenous children. In this way teachers will know more about their children and will be able to move from 'responsive mathematical pedagogy' to 'culturally responsive mathematical pedagogy'.

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