DIVERSITY IN APPROACHES TO MATHEMATICS EDUCATION IN A CULTURAL CONTEXT

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ABSTRACT

The purpose of the study was to explore the ways in which different schools met cultural contexts. Cultural context and language are important aspects of children's learning in school. The study involved observations and interviews in four countries. The themes that arose from the analysis were aspects of cultural context, meeting language differences in different ways, maintaining culture in different ways, teaching in a cultural context, teaching mathematics in a cultural context, having an emphasis on national values, using national language appropriately, and developing context-specific strategies for diversity. Each theme is illustrated by descriptions from the different contexts and discussed in terms of their impact on the learning in that cultural context. The differences were often unexpected but significant for our understanding about how school systems and teachers mediate context.

1 Introduction

The purpose of the study was to explore the ways in which different schools worked within cultural contexts. Cultural context and language are important aspects of children's learning in school. A classic book in this area (Harris, 1991) provided a fascinating account and recognition of the importance of Indigenous mathematics in Australia. This was followed by an approach to Garma Maths Project for the Yolngu community that built on their dual clan system, the naming of relationships between generations of the community, and locating places (Thornton & Verran, 1995). The need to address Indigenous knowledge in teaching mathematics was supported by others (e.g. Gale, McClay, Christie, & Harris, 1981; Stanton, 1994). Later programs were more general, provided in English and emphasised activities related to the environment and improved teaching strategies (Roberts, personal communication).

Meanwhile, Howard has shown over a number of years that relationships between teachers and the community are a key to education in western NSW, Australia (e.g., Howard, Perry, Lowe, Ziems, & McKnight, 2003). A number of programs based on this premise will be referred to later in the paper. Fanshawe (1989) had shown the personal characteristics of effective teachers of adolescent Aboriginals should include being warm and friendly, making realistic demands of students, acting in a responsible, businesslike and systematic manner, and being stimulating, imaginative and original. However, students continue to perceive teachers in less than a positive light (Godfrey, Partington, Richer, & Harslett, 2001) and may result from teachers' deficit perspective (Munns, 1998). Other countries have also effectively considered cultural contexts. For example, in the USA, the Yupik in Alaska have developed effective programs around cultural activities (Lipska & Adams, 2004) and Civil & Andrade (2006) have emphasised home-school relationships.

The current project is a comparative study to provide a wider context and perspective for such programs. It was anticipated that further insights into the purposes, benefits and approaches to teaching mathematics in a cultural context would be gained.

2 The Project

The project draws on observations and discussions in Australia, Papua New Guinea, Sweden, and the Republic of Yemen. Two schools in Sweden were selected because they were for Indigenous Sámi people. One was a primary school and the other for adults learning Sámi handicrafts and communicating in their own dialect (often as a second language to Swedish). I also held informal discussions with a number of Sámi community members. In southern Sweden, I visited a school with classes of children all having Swedish as a further language and three schools with little to high diversity of language backgrounds. In Yemen, discussions were held over two sessions with an experienced primary school teacher, two recently trained teachers, and a number of parents. By contrast, a man providing child care for African children and two European teachers were interviewed. In Papua New Guinea, information came from five elementary schools (pre-elementary, grades 1 and 2) in villages, three close to towns, and from conversations with other teachers, parents and teacher educators. I also draw on projects in western NSW Australia.

The discussions and observations were unstructured but I prepared myself by writing down possible questions to ask in each context. Since language is interwoven with culture, part of the study considered the language issues of the classroom. I recorded four discussions and made notes after all discussions and observations. The notes were read for themes. The themes arose from comments and observations that were notably different in the different contexts. The analysis has been strengthened by the selection of diverse contexts, some previous contact with the cultures, and opportunities to discuss with more than one person in order to check the information. The information is limited by being gathered over a short time period in each specific place (from 2 hours to a day in a school although I stayed in each area for more than a week).

3 Synthesis

Variation in the contexts highlighted the following themes:

- aspects of cultural context
- meeting language differences in different ways
- maintaining culture in different ways
- teaching in a cultural context
    - teaching mathematics in a cultural context
- having an emphasis on national values
    - using national language appropriately
- developing context-specific strategies for diversity

Each theme is illustrated by descriptions from the different contexts and discussed in terms of their impact on the learning in that cultural context.

3.1 The cultural contexts

In some cases, culture and mathematics were not seen as closely related until our conversations began whereas in other cases, thought had been given to students' background knowledge. In those cases, teachers were generally unaware of how their cultural knowledge could be well used in classroom settings.

In the host town, most of the Sámi people, a significant Indigenous minority in Sweden, participate in traditional Sámi activities and many families herd reindeer. The museum, called Attje (Sámi for store of knowledge), focuses on Sámi and North Swedish cultures. Some parents have learnt Sámi as adults and a number have taken time out of their careers to attend the Sámi Handicraft School. The Handicrafter Foundation has developed a touring display of the reindeer herders' life. They had wooden reindeer models on wheels, sleds for equipment, storage bags, and lassos. Students participate in a mini-travel around the school hall taking care of the reindeer, the family, preparing their places for sleeping in the lávvu (cone-shaped tent), tying the special knots for the reindeer straps, and marking the reindeer ears with geometric designs (the ears are recycled foam padding). They are made aware of the lightness of implements made from beech boles, pouches from reindeer skin that could fold up, size and shape of baby baskets. By learning about different aspects of family life, they experience incidental mathematical knowledge. The government provides significant recognition of the Sámi culture such as their land use, Sámi Assembly, and the impact of colonisation. The system provides additional funding for Sámi education. In the south of Sweden, I will mainly refer to a school surrounded by high rise buildings with mainly immigrant residents from many cultural backgrounds. The school affirms the diversity of these students.

I have elsewhere described the diversity of mathematical activity in Indigenous Papua New Guinean societies (Owens, 2001; July, 2008). In Papua New Guinea, students attend elementary schools built and maintained by village subsistence farmers with teachers who speak the village language. They are paid by the government but have minimal training for the difficult role of introducing concepts and skills in their own language. The role is difficult because the teachers must decide how to bridge from their own cultural concepts to English school concepts and there is little research in this area. There are over 800 languages so teachers must apply teaching strategies and principles of concept development to their own situation. Languages are traditionally oral and rapidly changing. Schools have minimal equipment but it is used relatively effectively.

I will refer to my experiences with schools in western NSW, Australia. Indigenous communities have been affected by invasion, colonisation and the results of colonial control such as occurred with the stolen generation, lack of appropriate schooling and banning of their languages. In my opinion, the impact has been greater than in Sweden where Sámi had recognised wealth in reindeers before colonisation. There is a government policy on Indigenous education, and Indigenous issues are part of teacher education. However, the importance of school and community relationships is still developing.

3.2 Meeting language differences in different ways

Both Sweden and Papua New Guinea have policies to encourage all children to learn in their first language during the first three years of school. At the Sámi school, there is a balance of teachers for whom Lule Sámi, North Sámi or Swedish is their first language and students spend some time daily learning in their first language. They continue to learn

their dialect through high school. However, most instruction after the first year is in Swedish as the common language and textbooks are in Swedish.

In the south, one team teaches in Arabic for the first three years while other teams have students with various languages but schools employ specific language teachers and assistants who can speak the language of some of the students. When time permits the teacher and assistant have time to meet to discuss the plan for the week. These assistants help with parent meetings and they can use the goals developed for each child by the parents and teachers. As teachers stay with the same class for three years they know the students and their families well. Teachers realise that there is a difficulty when children do not speak any home language well (Clarkson, 1992; Cummins, 1981).

In the south of Sweden, the children's section of the local library held some books in different languages while in the northern town, there is a specific Sámi library with material on a wide range of topics mostly in Swedish including those on school mathematics and research on Sámi mathematics.

In Papua New Guinea, elementary schools in the village area should use the local language as the language of instruction. However, with the increase in Tok Pisin (national lingua franca), many village schools use more Tok Pisin and either Tok Pisin or English counting words, often concurrently with their own counting system but some languages make limited use of counting. Many teachers have developed reading books in their own language and sounds are written to assist reading. They use pictures to promote oral work with some reading and writing. In towns, the language is generally Tok Pisin.

In Yemen, most expatriate children's parents are bilingual. The small number of European children attend the local school for mathematics and Arabic language to supplement the curriculum delivered by teachers from their European country in their home language. They make regular visits to Yemeni families with their mother and participate in everyday living like shopping. Immigrant Africans attend schools learning in Arabic or a private school. Yemeni government schools teach in Arabic, the home language of Yemeni children. In some private schools attended by mainly Yemeni children, they are learning to read and write in English partly due to the teachers' language and textbooks which have considerable drill and practice exercises for homework.

In western NSW, one local program raised teachers' awareness of culture and Aboriginal English and alternative effective teaching strategies to improve the writing of Standard Australian English (Owens, 2004; Reid & Owens, 2005). In the high school, this involved teachers of other subjects having a literacy focus.

3.3 Maintaining culture in different ways

In Sweden, a series of books gives stories from children from different cultural groups written in each child's language. One of these was about a young Sámi girl written in one of the dialects. The Attje, books, teachers, Handicrafter Foundation, Sámi Handicraft school for adults, Sámi market, and extended family are significant resources for students in Sámi areas. Swedish texts have some reference to Sámi culture but mostly to common everyday living experiences. In the south of Sweden, there is also an awareness of international issues but less so of Sámi culture. Children are permitted to wear clothes acceptable to their families.

The European teachers in Yemen noted that their culture emphasised a well-rounded education. This was not to be jeopardised for the children living in Yemen. The African

child-minder noted that he provides early mathematical experiences in their common language using strategies by which he was taught in Africa. The Yemeni government schools teach Koranic history as a focus of history/geography lessons. The local museum emphasised the antiquity of Yemen writing and cultures and also the determination to be their own rulers and to recognise the long-standing revolutionary spirit of their democracy. This is in contrast to other Yemeni cultural requirements.

In Papua New Guinea, the elementary school focuses on culture. The *Culture and Mathematics* syllabus provides guidelines and outcomes that can be implemented in different language groups. The transition to English is gradual and culture and language should continue to play a part in higher levels of schooling. Teacher education institutions provide ways for teachers to explore the culture of their school students.

Some of the children in the bidialectal approach to teaching Standard Australian English identified with the Aboriginal English. They also responded positively to the presence of older Aboriginal people in the classroom as assistants, the change of teaching strategies that promoted higher order thinking, the focus on language, and knowing that the teacher further understood the background colonisation difficulties of many Aboriginal families. Other programs were also introduced around the same time including tutors in school and special cultural programs for boys.

3.4 Teaching in a cultural context

In the multicultural school in Sweden, teachers commonly used the cultural background of the children. The classrooms are calm, the students are active and talking about their school work. Students are carefully seated at the groups of table so that all students have a good chance of learning. The teacher had placed some girls together as they cooperated well and were not disrupted by the more boisterous boys. The grouping took account of level of achievement and level of Swedish.

In Yemen, culture impacts on the class group. Teachers commented that schools for boys are noisy. Mathematics was not connected to a large historical celebration due to teaching time lost to practices but also because the textbook with explanations and exercises guides the teachers. Teachers commented that the best way to have students learn is to be kind to them (physical discipline occurs), to make jokes and have fun, and to be well prepared to discuss the topic rather than the students reading the textbook before answering the set questions. Teachers and texts make work relevant to the students' lives.

Like Yemen, Papua New Guinean cultures deeply impact on everyday life but in a different way. Like Sweden, schools in Papua New Guinea are for both boys and girls but, like Yemen, poverty and gender inequality may impact on opportunities and attendance at school although nearly as many girls as boys start school in Papua New Guinea. Schools are generally close to the community and what happens in the extended family will impact on the school. Story telling is an important tradition so teaching involves many long and short stories. Stories about pigs, dogs, chickens, plants and people are common.

The European teachers in Yemen had training on multicultural teaching and there were books for children from other cultures. Emphasis in preschool and lower grades is on social and personal development whereas in higher grades, teaching specific content is well developed. Students in schools in Europe from other cultural groups are encouraged to explain about their culture and to feel proud of it and their country.

In western NSW Australia, the culture and family ties are strong despite the loss of language. The *Review of Aboriginal Education 2003-2004* identified the following areas:

- explicit teaching for literacy and numeracy outcomes
- engaging Aboriginal students in relevant and stage appropriate curriculum especially in the transition years including the transition years between pre-school and Kindergarten and stage 3 and stage 4
- embedding and integrating Aboriginal cultural knowledge to enhance Significance, Intellectual quality and a Quality learning environment (QT)
- encourage and foster close links with local community Aboriginal networks with a focus on increasing student engagement in learning
- implementing the NSW Quality teaching (QT) framework to improve teaching and learning experiences for Aboriginal students.

The Australian government has funded projects to improve the learning outcomes for Aboriginal students in Literacy and Numeracy and for all students. Teachers identify needs within a school or cluster of schools. Teachers use an action learning approach to bring about and evaluate change. A number of these projects are discussed below.

3.4.1 Teaching mathematics in a cultural context

At the multicultural school in Sweden, teachers had a meeting with parents using equipment at learning centres so parents could note what they learnt from cards, blocks and games. The teachers developed a scenario about a family of seven who lived in one of the local apartments. For mathematics, once per week, the grade 3, 4, and 5 children formed small groups to solve mathematics problems about the family, recording in their own books. The teachers had provided some problems and shown children how to make up more. As a result, there were 200 problems prepared by the children about the family. There was a wide variety of levels and children were beginning to select ones that challenged them. The children's problems were laminated. Mathematics of other cultures was not well known by teachers although a recent teacher education subject and a local high school subject provided some work on language and mathematics of other cultures.

Sámi teachers referred to the reindeer herding in terms of the idea of instant recognition of numbers and shape/colour configurations, they talked of the importance of comparing in making handicrafts. The links between Sámi ethnomathematics and school mathematics are still to be developed.

In Yemen, textbooks are upgraded regularly. Generally students work by themselves from the textbook, they might talk to their neighbour or put their hand up for teachers to help. Textbooks provide sufficient time for teachers to explore new concepts through discussion and do not require extensive rote practice. Since most students do not go to preschool, the Kindergarten allows children to learn through play, leaving most counting and arithmetic to begin in grade 1 with patterns being about colours. Ten frame pictures are included in the textbook for grade 2. Koranic history and money (but often referred to as 1 to 100s with thousands implied) provides opportunities for experiencing large numbers. Teachers also use their own examples that relate to Yemen such as "You are travelling to Sana'a which is so many kilometres away and you have travelled so far, how much further is Sana'a?" The textbook for older primary school students covers percentage questions related to store keeping, buying, selling and profit. Many families have small businesses. The teachers mentioned that they use the children at the front of the large class in "games" to group children for addition, to take away a group for subtraction

and to remove equal groups for division. One teacher mentioned that she refers to borrowing gas from next door for subtraction by decomposition. She talks about big mouth for “greater than” which is like the first letter in the Arabic word. She places on the board cardboard cutouts of base 10 blocks to explain addition and subtraction and to make the links to the pictures in the textbook. {It should be remembered that class sizes are large and students have no equipment beyond rulers.) Textbooks are colourful and carefully graded and give basic explanations and examples. Pictures in textbooks are relevant to Yemen e.g. a picture on ordinal numbers shows children entering a typical local school building, local sheep and many other animals (not pigs) and plants are used in pictures. Teachers collect and mark work everyday while the other teacher takes the class. Questions are designed to involve the students so, for example, children measure the sides of the rectangle to determine its name and a page on rectangles and tessellated rectangles has dots which children could join to form the tessellated rectangles and thus develop a strong sense of the rectangle and the lengths of its straight sides. Despite nearby buildings having mosaics and designs, these are not referred to by the teacher as she only refers to items in the school room which the children see immediately. Circle geometry which links to the semi-circular coloured glass windows is not part of high school.

The European teachers noted that preschool and kindergarten teachers could be creative with teaching mathematics by relating to cooking, counting steps, playing games and learning through play. Numbers like “forty five” are “five forty” in both their home language and Arabic. However, symbols for some numbers are easy to confuse between their home language (same as English) and Arabic. The teachers use textbooks but make mathematics relevant to the students’ contexts. For example, “if you have so many mosquito bites in a day, how many in a week.” They provide experiences that are useful in both countries such as money in both euros and rialls and they convert roughly as a fun activity. The children make up their own word problems to have fun. Readers and geography books involve mathematics so the teachers draw the mathematics out of these texts, for example, on the size of countries, population, highest mountain etc.

The African child-minder expressed his value of cultural knowledge and practices. He mentioned the lack of environmental objects when he was growing up so each corn kernel on a cob was used to learn to count and do arithmetic and if this was not available, then children counted teeth, eyes (covered and uncovered), and other body parts. They recited information and he was using similar methods with the children in his care. He also discussed issues related to mass. He pointed out that the basket *falasula* used to give a common mass in Yemen was different to that in his home African country, that the price for 100 falasula and 1000 falasula of different types of coffee is given on the radio. He noted that the merchants brought sacks to villages to fill with wheat and maize and they paid by the sack load but they sold by the kilogram, making a profit. Similarly they would purchase say 17 falasula and give the price for 15. Two yards was said to be an armspan or fathom. Rope was cut for this length. The round houses, large and small, also made use of the radius. It was kept for others to use to get the same size. The area of the base was checked by an expert as an exact circle provided strength against winds. The central pole and the spokes like an umbrella are prepared for the roof and checked. They have a curve to reduce the flow of rain. This is then raised to the required height. He noted that his teachers did not make connections between the use of a protractor and the circular house

building nor mention the patterns used to make hats. Shapes were only taught at school isolated from cultural knowledge.

In Papua New Guinea, counting systems are recited but teachers may not have figured out or heard of the principles of analysis which could facilitate the use of vernacular language to teach arithmetic. In some cases, speakers of the same language have worked out different ways of counting in their language. Measurement concepts are embedded in comparisons and activities like house building. Languages vary considerably in the way they might compare objects, sizes and shapes, and to what extent they carry out numerical operations. They also have their unique ways of describing positions. Elementary school teachers use available materials like sticks, stones, plants, plant stems cut to make 3D shapes, old bottles, bottle tops, newspapers and knots in ropes. Teachers paint or draw their own pictures or use the gardens, houses and children to illustrate mathematics.

In NSW Australia, adaptation of state programs such as *Count Me In Too* (CMIT) for Indigenous communities encourage staff and parents to participate in making the materials to be used in class and in understanding the school mathematics of their children. Australian animals are used in the materials. Indigenous assistants help with learning in group work and the teaching strategies and framework are improving numeracy. There are projects on mathematics in context. For example, the mathematics teacher worked with the Indigenous staff and community to develop a unit on mapping with the students visiting the area of town where many Indigenous families live. This site is of cultural significance for the Indigenous students. The Indigenous students showed a sense of ownership and engagement with the mathematics. The project provides an opportunity for the non-Indigenous students to learn incidentally and informally more of the Indigenous culture of their fellow students. For many years, this teacher has provided parents with several weeks of evening classes in mathematics so they can understand their children's home work. These are popular and the after-hour involvement of the teacher in the community is highly valued. In another town, teachers engaged students better by improving their teaching strategies for the Space strand of mathematics and their connections with the Indigenous community. In other schools, teachers implemented *Outback Maths* which was a way of relating mathematics to other subjects and to the students' environment through a series of lessons on topics like The River or The Show.

3.5 Having an emphasis on standard values

In all schools in Sweden, the children are made to feel "at home" at school. There is informal talk about families between the teacher and the children. In the southern Swedish school, each child is greeted at the door with a hand shake and a conversation may begin. The desks have pencil holders but also flower pots and candles (a typical way of making the environment warm and welcoming). The children are encouraged to mix and show respect for each other, and to eat and drink with the other children.

In Australia with schools having high Indigenous student populations, children are expected to respect their elders. The teachers are expected to respect family commitments, understand typical ways of expressing issues that could be misinterpreted by children as a result of dialect and cultural differences, and recognise and cater for learning difficulties especially those caused by otitis media, a common ailment in children. Sweden, Papua New Guinea and Australia emphasise equity and acceptance of cultural diversity. Yemen is encouraging more girls to go to school.

3.5.1 Using national language appropriately

In Papua New Guinea, Sweden, Australia and with European children in Yemen, despite recognition of home language and varying degrees of being taught initially in the home language, the goal is to be competent in the official language. The argument is that for social equity students need this level of language. Papua New Guinea, Sweden and the European children in Yemen will be expected to be literate in their home language but this is not a focus in western NSW nor some schools in Yemen that concentrate on English. Some European schools require students to learn the national language prior to entering grade 1 and transition classes are provided for this purpose. Sweden will provide small group tuition for new migrants in older years and Australia provides tutors for older students needing assistance in literacy.

4 Unique Strategies for Diversity

The interesting aspect of the Swedish, Australian and Papua New Guinea systems was the funding that provided schools with an opportunity to adapt schooling to the contextual needs of their students. Teachers received sufficient training to recognise diversity. However, implementation in the classroom may have been more problematic given that either the home languages and cultures were different to that of the teachers or there was insufficient knowledge of how to bring about a transition between knowledges. Resources are also an issue. Reading materials for small numbers of speakers of a specific language require expertise and time to write and are costly to produce.

The synthesis of information for this study indicates that there are multiple approaches for educational systems and individual teachers to meet the unique cultural context of their classrooms. In some cases, the whole school had a cultural focus within the wider community context or policy. This was the case with Sámi schools in Sweden. Nevertheless, difficulties developed with a need for research and funds for further developing the school's materials to have a Sámi focus. In Papua New Guinea, the principles are in place but the resources and training are limited. In addition, further research is needed. In Australia, funding is available, projects are effectively implemented and teachers are being well educated in cultural issues both in preservice courses and within school settings. However, the issues relating to mathematics are not as dominant as the relationships between teachers, students and the community. In Sweden to engage students, schools are developing their programs for multicultural schools but it is the very diversity of the students' differences in any one school that requires managing. Context is seen in terms of today but there is little recognition of cultural mathematical knowledges.

Effectively managing relationships and differences is a daily issue assisted by cultural knowledge and efforts to bridge the language barriers. For example, teachers may show the community, parents and students that they value the home language and knowledge, or intermediaries may negotiate, or informal and formal sessions may be available for parents.

At the teacher level, communication skills are paramount. Welcoming processes are necessary whether through the physical environment, through the presence of members of the community in the schools, through language, through the selection of activities and through the teacher getting to know the students either in or out of school, the latter often happening in small communities where teachers belong to the family or village.

Reconciliation may be needed given the backgrounds, the unexpected misunderstandings and the differences in power relationships that are inevitably involved with schools, migration patterns and wealth. Bringing together different knowledge bases requires time to understand the other knowledge, time to give students an opportunity to express their knowledge and interests, and resources (written materials and teacher education) for meeting diverse backgrounds.

To improve teaching mathematics in a cultural context, teachers and systems should address each of the following: knowledge of the context, awareness of the impact of language, maintaining culture, teaching within the cultural context, researching and using the links between cultural knowledge and mathematics, recognising values that are being taught incidentally, developing strategies to learn in the home language but to become literate also in the national language, and developing both national and school strategies to meet the diversity.

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