Culturality in mathematics education

A comparative study

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The purpose of this paper is to draw upon extensive multicultural experiences and research to present some key aspects of effective multicultural teaching and learning. With an emphasis on cultural context and language, the discussion uses examples from Sweden and Australia, although experience and research in other cultures have informed the perspectives. Aspects of culture that are relevant to mathematics and approaches that maintain culture are emphasised. An emphasis on national values and language is also influencing schooling but strategies that take account of diversity of language and culture are provided.

This paper is a synthesis of my experiences and research over a forty year period in cross-cultural education in different countries and cultures around the world. The result is the formulation of a set of key issues which need to be addressed in multicultural classrooms in mathematics education. I start by telling my story in brief to indicate some pertinent life experiences which reflect historical issues. I will focus on language and culture in Australia and Sweden although the diversity of research experiences in other countries such as Papua New Guinea and Yemen were part of the study and reflexivity to decide the keys for effective mathematics education. The terms "culturality" and "multiculturality" refer to identity based on culture and language. For students in multicultural classrooms or with the main language of schooling being different from that of their families, identity will become culturally multifaceted.

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My story

I begin with my first knowledge of Indigenous Australians. At school we learnt little except that 'Aborigines' lived here long before this land became a British penal colony. We also heard that the explorers went through land where Aboriginal people lived but we had no idea that they still had connections with the land. We knew Aboriginal people had a Dreamtime but not its significance. In the 1950's we thought boriginal skills and beliefs were only a feature of 'full blood' communities in remote areas of Australia. However, my father was keen to give us a good education from non-school experiences. When showing me the different kinds of industries he serviced, we passed through Redfern and he pointed out some Aboriginal people and mentioned that a large number lived at La Perouse.

At a church group for girls, I heard about people in many different countries unlike most of my other school friends, albeit from an expatriate point of view. I met and read letters from a missionary family who lived in a remote Northern Territory area and taught in the local Indigenous language. They had a strong respect for the people. I also visited a mission farm on the outskirts of Sydney where many children had been sent from the Northern Territory to live. We were told the children were neglected by their families and were only brought there if the government could not organise better care with their extended families. Some children went back to their families and some ran away. I wondered if any of them reached their families (thousands of miles away). Various policies for taking Aboriginal children from their families continued into the 1970's. I was aware that developing identity and self-esteem as a young Aboriginal teenager in New South Wales (NSW) was particularly difficult.

In my first year of university (1964) I joined the Student Action for Aborigines (SAFA), full of active mainly left wing students and led by an Aboriginal student, activist, soccer player and leader Charles Perkins. The start of the next year saw the *Freedom ride* to highlight racial discrimination and poor health conditions in outback NSW towns. Midyear I went to Walgett and stayed with Harry Hall and his family on the river bank. We visited families on the reserve across the river. We held meetings with the town's people who were keen to share facts about discrimination and plans for a better community. In the street, we were jeered at by local white children; no one seemed to know that a university was a place of education. On this occasion, the white and black friends were arrested for standing quietly on the stairs of the picture theatre waiting to be seated upstairs (Aboriginal people had to sit in the stalls downstairs). The police fabricated evidence so Harry's daughter was the first Aboriginal woman

to be arrested for protesting in NSW. SAFA finished after two years. At the same time, in 1966, the Gurindji, one of many Indigenous language groups in the north of Australia, walked off a pastoralist's cattle station in protest (Hardy, 1968).

I joined the student group called *Abschol* (Aboriginal Scholarships Scheme) and we organised the first national Aboriginal education conference in Australia (Roper, 1969). At the conference a teacher from South Australia spoke of the effectiveness of first teaching in the children's home language and later continuing with bilingual education. An Abschol work camp saw us assisting with repairing houses on a reserve in South Australia where depressed Aboriginal people in government housing lived with a white station manager. Around 1910, the local mission had taken young teenagers from the families to live in the boys and girls homes to provide a 'Christian' influence. We visited Yalata in the desert where the old fellows and families had more intact cultural living and the teacher occasionally visited the place where the humpies (one metre high shelters) were built. The men shared some of their knowledge and skills. The people at Yalata had a stronger self-identity than those on the reserve. We demonstrated to support the 1967 referendum in which Aboriginal people were to be regarded as citizens for the first time. Later antidiscrimination laws were passed. The Foundation for Aboriginal Affairs, Student Camp Association (SCA), and Tranby were all places where I saw Aboriginal people working together with white people to improve education and opportunities for Aboriginal people. Nurturing confidence and pride in their Aboriginal identity were main goals of the SCA camps.

In 1973, after marrying, I moved to Papua New Guinea (PNG). I enjoyed 15 years of rich cultural experiences. There are over 800 languages, cultures, counting systems and other mathematical practices in PNG. I learnt much as a health educator about the cultures before delving into mathematics and culture. I wondered why one of my older students in preliminary year at the PNG University of Technology could not add. Later I learnt that he came from an area where the counting systems were based on just the words for one and two. He may have had a body-part tally system. My colleague Glen Lean took 22 years to document and analyse over 600 counting systems from PNG and Oceania (Lean, 1993). His work formed the basis of the collection at the Glen Lean Ethnomathematics Centre at the University of Goroka. More recently the university staff and myself have been recording and analysing measurement processes and knowledge, and considering how Indigenous knowledge can enhance school learning and curriculum (GLEC website).

Back in Sydney Australia, I visited multicultural schools near my university and carried out my doctoral research in four primary schools. I taught in a block-release Aboriginal Rural Education Program. After 15 years I moved to rural NSW to Charles Sturt University, my current workplace. I live and work on Wiradjuri land, the largest language group in NSW. The Wiradjuri and Gamilaroi communities were moved to a reserve outside of town under the Aboriginal Protection Act and now many have settled in town, often close to other Aboriginal families. Several smaller language groups moved to town from areas further west where their rivers have been severely degraded by farming activity and dams.

My first visit to Sweden was on a lecturer exchange program (1996) and I have returned several times for various conferences. One of these included a Sámi ethnomathematics conference where I met Ylva Jannok Nutti from Luleå University of Technology. Subsequently Ylva organised a study tour in Jokkmokk and Luleå. Annica Andersson from Malmö University organised visits to multicultural schools in the south of Sweden. I also had extended stays in Yemen, a poor Arabic country.

All these personal experiences have been fundamental in making me aware of the importance of appreciating and understanding diversity. Dominant cultures tend to create a view of minority cultures as being deviant or deficient. The norms and values of the colonising culture are used as a measure against which these communities are confronted. My experiences have made me aware of the impact of assimilation policies on Aborigines in Australia and in other places in the world. Assimilation, understood as assisting minorities to take on the values and behaviours of the mainstream society, does not acknowledge the worth of different values, different knowledges and different ways of knowing. It does not acknowledge the fact that diversity is a source of learning. But despite the devastating effect of assimilation and colonisation for many families and entire communities, the communities own cultural values, such as kinship for Australian Aborigines, have remained a strong entity. My Aboriginal friends as well as many other peoples have not only provided friendship but also challenges to my thinking and beliefs as a white Australian belonging to a dominant culture. This has been an important source for engaging in a critical approach to knowledge building, research data and communication.

I have studied different practices in the different countries to see how cultural diversity impacts on mathematics education in different ways. However, I have distilled some common themes (Owens, 2008). I will discuss each of these key points for quality culturally based mathematics education, drawing on observational and interview data and research related to Sweden and Australia. These points are based on the premise

that "ways of acting, interacting, talking, valuing, and thinking, with associated objects, settings, and events" results in the constitution of meaning (Gee, 1992, p. 141). Those ways are cultural and fundamental to learning mathematics in school.

Comparison of Sámi and Indigenous Australian pasts

I trust that my story will assist Nordic readers to make links not only to their own past but also to the current challenges posed by diversity, as I describe some historical similarities and differences between invaded and colonised Australian Indigenous and Sweden's Sámi groups. The past is the present and the future, an important Indigenous concept that should not be forgotten in school education settings as well as cultural community settings. My past experiences are still unfolding as I learn more from my local Aboriginal community, my continuing visits to PNG, and communications with my colleagues in Sweden and at international conferences focusing on ethnomathematics and multilingual education.

Australian Indigenous and Sweden's Sámi groups followed the seasons to varying degrees and for different purposes although food, water, shelter, and cultural connections and the natural environment impacted on the way of life of all these groups (Parbury, 2005). Since the members of the group needed to move, they kept possessions light and minimal in both countries. Designs of artefacts are curved, practical and seldom excessively decorated. There is a harmony between colours, design and ornamentation (Nicholls, 2003; Sameslöjdstiftelsen & Sunna, 2006) although contact with other people (for example, the Sámi's opportunity to purchase cloth and yarn from England) may have varied the colours. Activities like dance and artefacts link to the environment and to stories that are significant in portraying relationships between people. Similarity exists in the naming of seasons according to the environment and in the making of maps that depict relationships with the land (Harris, 1991; Jannok Nutti, 2006). The Sámi with the extreme climatic changes have eight identified seasons, whereas in Australia variations occur between language groups with reference to winds, rains, rivers, animals, plants and activities such as setting grass fires.

The historical similarities between Indigenous Australians and the Sámi regarding the taking away of their land, discriminatory policies that were developed and schooling of Indigenous students are remarkable. Indigenous lands were given by the government to farmers in both cases. In Australia settlers claimed the land without any government recognition of the rights of Indigenous Australians while reindeer herders in Sweden were expected to pay for their land (Lundmark, 2007). The

disregard for the rights of Indigenous Australians and Swedish Sámi was opposed by some colonists resulting in laws that tried to protect the Indigenous groups but these laws created their own serious problems and maltreatments. In Australia, this included special reserves, pass systems and special schooling (often substandard schooling). Children were frequently removed from their mothers on the pretext of illegitimacy or poor hygiene with no regard to the importance and rights of mothers, children and the extended families. Near Dubbo, removal of girls was said to be 'protection' from local white farmers (Harris, 1994), and for government-condoned provision of 'half-caste' women for rural farms. Abuses occurred. In summary, Australian history indicates variation through time and place of the protectionist and assimilation policies (Harris, 1994) but the results of this enforced disintegration of family have been devastating and lasted down through generations (Human Rights and Equal Opportunity Commission, 1997). A healing must take place for the stolen generation and their families.

As part of the policies of protection, schooling and assimilation, Indigenous Australians were prevented from speaking their language both on the reserves and at school. During the 1960s, some parents deliberately moved to town off the reserve and spoke Standard Australian English to improve their children's chances at school. Self-determination has been a focus for three-quarters of a century with most communities working quietly to achieve it (for example, Pearl Gibbs and Bill Ferguson and the Aboriginal Progress Association in Dubbo). Indigenous communities are still taking matters to court to gain land rights, and reconciliation marches and action plans continue to show the need for improvements in Indigenous Australians' rights and well-being.

In Sweden, opportunities were given to children to attend school but this often meant separation from the family. Many were concerned at the quality of the schooling and whether it was equal to education provided to Swedish children (Lundmark, 2007). At one time, teachers travelled with families in the summer and provided schooling for the winter months in the nomad schools. In the past, the Swedish language was forced on students in some places and some were forced to attend a Sámi school. Now learning in the mother tongue and attending Sámi school is highly valued by Sámi including those whose parents encouraged them to have Swedish as their first language for the purposes of giving them better opportunities.

In 1998 the Swedish government apologised to the Sámi people for Sweden's oppression of the Sámi. The refusal to let the Sámi use their own language and forcible displacements of Sámi groups were mentioned as examples of such oppression. There is a Sámi parliament with some

decision-making powers and some strengthening dialogue with other parliamentary and government institutions. By contrast, only after a change in the Australian government, the prime minister made the long-awaited apology in February 2008 with several reforms but there is still much to do for reconciliation and there is not the degree of autonomy in government as in Sweden. Except in the 1920's and 30's, most Sámi have not lived in poverty whereas Aboriginal people were forced to accept handouts rather than wages, to live in places where there was no source of monetary income or it was withheld, and to suffer the social and health problems that have arisen with colonisation. Today people receive government support but historical damage is hard to overcome and a recent decision by the previous government for intervention in Northern Territory communities again highlights the need for self-determination by each community.

To illustrate a further difference between Indigenous Australians and the Sámi, we can look at languages. In Sweden the Sámi have three main dialects and some people speak one of the dialects as their first language or bilingually. Indigenous Australia has at least 270 languages across a number of language Phyla with some language Isolates and some with several dialects or varying degrees of creolisation. Although perhaps only 100 are spoken to varying degrees, there are at least 20 of the languages spoken as a first language by all or most members of the community. Aboriginal English has a distinct grammar and varies from community to community as a result of links to the original language of the area. It is, however, a part of some Indigenous Australians' identity. In the central west of NSW, the Wiradjuri community are reviving their language as some words have been generally spoken despite their history, and there are early first contact records of the language and a few older members who still speak the language fluently. Despite language loss, the Indigenous groups strongly identify with their language group because of the strong kinship system. It is not possible to teach Indigenous students well unless this historical context is acknowledged.

Key issues in multiculturality in education

Having set the scene, I would like to take you as the reader to where I believe education can consider this past and yet provide effective, progressive education. Details of the sources of the observational and interview data that has informed this paper can be found in Owens (2008). Themes emerged as a result of my reflection on experiences and data taken from the four quite different countries where I have studied culture and mathematics education. As Atweh (2007) points

out, international comparisons can lead us to reanalyse our views of mathematics and of teaching in a cultural context. The six identified themes (Owens, 2008) are:

- valuing the cultural context,
- maintaining culture in different ways,
- teaching in a cultural context including teaching mathematics,
- having an emphasis on national values and using national language appropriately,
- developing context-specific strategies for diversity, and
- meeting language differences in different ways.

In the current paper, each theme is illustrated by descriptions from different Swedish and Australian contexts and discussed in terms of their impact on the learning of mathematics in that cultural context.

Valuing the cultural contexts

After Alan Bishop visited PNG, he wrote of the importance of enculturation in mathematics education (1988) and in more recent years has collaborated to emphasise the importance of continuities in cultural transitions in mathematics education (de Abreu, Bishop & Presmeg, 2000). There is good evidence from many mathematics educators working in ethnomathematics to note how important culture and language are in learning (Barton, 2008). When one begins to talk about culture and mathematics, many teachers do not expect to see a relationship. However, in other places (e.g. Sámi and PNG) consideration has been given to students' background knowledge. When teachers become aware that there are mathematical activities in cultural practices, they may start thinking about how the students' cultural knowledge could be part of classroom mathematics.

In Jokkmokk, most of the Sámi people participate in traditional Sámi activities and several families herd reindeer. The museum, 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 (with government funding) has developed a touring display of the reindeer herders' life. They have 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, and size and shape of sleighs and baby baskets. By learning about different aspects of family life, they experience incidental mathematical knowledge.

In the south of Sweden, the school that I visited was surrounded by high rise buildings with mainly immigrant residents from many cultural backgrounds. The school affirms the diversity of these students in many ways through staffing, learning experiences, language and stories. Children are permitted to wear clothes acceptable to their families and the children's section of the town library holds some books in different languages.

In the 1980's and 1990's, research in northern Australia showed that there was a distinct approach to patterns and relationships and to mathematical topics such as locating (spatial position). Yolngu community had a clear duality system relating position, people and the environment and patterns in naming relationships between generations (Thornton & Verran, 1995). Harris (1991) provided a fascinating account and recognition of the importance of Indigenous mathematics, e.g. locating and time, in remote communities in Australia. The need to address Indigenous knowledge in teaching mathematics was supported by others (e.g. Gale, McClay, Christie & Harris, 1981; Stanton, 1994). Later programs in English were more general and emphasised activities related to the environment and improved teaching strategies (Nicholls, 2005; Roberts, 2001). Several education consortiums (e.g. Queensland University of Technology; RMIT Melbourne; Monash University, Melbourne) are now working with remote or rural communities to assist them develop their own curricula and to develop education that is beneficial to the community while others are focussing on communities in early childhood and later education (e.g. Charles Sturt University, NSW).

Maintaining culture in different ways

In Sweden, a series of books gives stories by children written in their own language. One of these was about a young Sámi girl written in one of the dialects. The Attje, books, teachers, Handicrafter Fundation, Sámi Handicraft School for Adults, Sámi market, Sámi library (although most books are in Swedish) and extended families 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.

Recent projects in Australia have seen a number of books produced about Dreamtime stories, sporting and other heroes, and stories of families (e.g. Indig readers). Other books use Aboriginal English (Kidd, 1998). Aboriginal English was recognised in the bidialectal approach to teaching Standard Australian English and some children identified with Aboriginal English (Reid & Owens, 2005). It was the presence and assistance of the Aboriginal research assistants in the classroom that enabled the children to be included in the classroom discourse and engaged in learning. Students enjoyed the learning experiences in a way that related to them through narrative, familiar language and often family connection. As a result of the project teachers had a far greater appreciation of Indigenous culture, the impact of colonial history on individual families and a greater appreciation of their students' home lives. It was important to students that their teachers were communicating with senior community members in the classroom and they knew that the teachers were aware of and valued their culture. Other programs were also introduced around the same time including special cultural programs for boys. In another school, a group of local Indigenous elders and parents shared their past experiences and teachers regularly visit the Indigenous parents' meetings. One teacher said, "Why in my 20 years of teaching here, has it taken so long for me to hear these things. It has changed me as a teacher" (unpublished school project report, 2007).

Teaching in a cultural context

In the bidialectal project in Australia, there was a significant increase in the quantity of students' writing and in many cases a significant improvement in the quality of their writing (Reid & Owens, 2005). Changes in teaching strategies included more games and revision of work, a cross-curriculum focus on language, clarity of important aspects of the topic, empathy and ensuring children had a sense of achievement.

Howard (e.g. Howard, Perry, Lowe, Ziems & McKnight, 2003) has shown over a number of years that relationships between teachers and the community are a key to education in western NSW. Fanshawe (1989) showed that the personal characteristics of effective teachers of adolescent Indigenous Australians should include being warm and friendly, making realistic demands of students, acting in a responsible, business-like 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) which may result from teachers' deficit perspective (Munns, 1998).

In western NSW, the culture and family ties are strong despite the loss of Indigenous languages. *The Review of Aboriginal Education* 2003–2004 identified the following areas as important for Indigenous students:

- explicit teaching for literacy and numeracy outcomes,
- engaging Indigenous students in relevant and stage appropriate curriculum especially in the transition years of starting school and secondary school,
- embedding and integrating Indigenous cultural knowledge to enhance significance, intellectual quality and quality learning environment (cf., NSW quality teaching framework), and
- encouraging and fostering close links with local community Indigenous networks with a focus on increasing student engagement in learning.

In a number of funded projects (NSWDET, 2007), teachers identified needs within a school or cluster of schools and used an action learning approach to bring about and evaluate change. Many of these projects, as in other countries, involved mathematics education (e.g. ASISTM projects in Australia).

In NSW, various projects for Indigenous children e.g. *Count me in too Indigenous* are improving numeracy and involving parents, teachers and Indigenous school officers to develop their approaches and resources (NSWDET, 2007). The early arithmetic projects were directed by the Department more than the following projects. A mathematics teacher (Harry Langes) 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 provided an opportunity for the non-Indigenous students to learn incidentally and informally more of the Indigenous Australian culture of their fellow students. In another town, teachers engaged students by improving their teaching strategies for the space strand of mathematics. 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 (Lewis, personal communication; Nelson, 2005). These projects become sustainable because of the involvement of the community.

At the multicultural school in Sweden, teachers held a meeting for parents during which parents could move around to different learning centres and 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 provided some problems and showed children how to make up more which were also laminated. As a result, there were 200 problems prepared by the children about the family. From the wide variety of problems, children were beginning to select ones that challenged them. 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 (Andersson, personal communication). Some mathematical areas are often strong in other cultures, e.g. circle geometry in Arabic art. Estimation skills (not necessarily matched by language) are strong in Indigenous, subsistence cultures (Owens & Kaleva, 2008a, b), and among artisans (Mitchelmore, 1983) but there is a challenge to make this tacit knowledge explicit to allow for the connection between home and school knowledge (Frade & Borges, 2006).

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 being developed (Jannok Nutti, 2009). Other countries have also effectively considered cultural contexts. For example, in the USA, the Yup'ik in Alaska have developed effective programs around cultural activities (Lipska & Adams, 2004), and Civil and Andrade (2006) have emphasised home-school relationships. In PNG, the elementary school curriculum is called *Culture and mathematics* and ethnomathematics is valued (Owens, 2000).

Having an emphasis on standard values and national language

In the schools that I visited in Sweden, the children were made to feel "at home" at school by having homely decorations like flower pots and candles. There was informal talk about families between the teacher and the children and each child was greeted at the door with a hand shake. The children were encouraged to mix and eat together and to show respect for each other. In the multilingual schools, the classrooms were calm and children were arranged at desks to facilitate all children's learning. For example, cooperative girls were placed together away from

boisterous boys. There were many displays and people from a variety of cultures. In Australia, Indigenous children are expected to respect their elders, and teachers are to respect family commitments and cultural differences.

In Sweden and Australia, one educational goal is to be competent in the official language. It is argued that for social equity students need to have a reasonable level of the official language. In addition, students in some countries like PNG and Sweden are expected to be literate in their home language. Sweden provides small group tuition for new migrants in older years and Australia provides tutors for older students needing assistance in literacy. Mathematics teachers may specialise in teaching students with English as a further language.

It was found, in a preschool setting, that children assist each other very slowly to speak the national language but factors such as the table mix of languages, the amount of national language understood and spoken at that stage, the child's choice of playmates, the children's personalities, and non-linear rates of learning, influenced the progress made by children. However, it was important that teachers spent time with each group of children (Fassler & Genishi, 2003).

Developing context-specific strategies for diversity

Strategies for Indigenous communities will have some similarities and many differences for communities with a high multicultural community. In most Indigenous communities there are multiple language groups or dialects as found in Jokkmokk and Dubbo but this is not always the case (e.g. in village schools in PNG or remote areas of Australia). The role of elders or community leaders may vary between Indigenous and multicultural communities. The support from government may vary and the space for decision-making by the family may vary. Nevertheless, the community involvement will be crucial for successfully achieving mathematics education that takes account of cultural diversity. In some cases, this is planned. In the recent Australian Indigenous projects, guidelines required an indication of how the community would be involved. In the south of Sweden, much of the involvement might have been at the individual child conference or as a result of the high employment of personnel, of community or language speakers. However, teacher knowledge of community mathematics requires further professional development. The extent to which the community has a voice is dependent on school and national policies.

In some curricula, there is little detail on implementation providing for greater autonomy at the school or community level (e.g. Sweden, PNG

and Yemen). However, in most cases, national testing regimes or textbooks could stifle the opportunity to develop context-specific strategies. Curriculum documents in Australia tend to be quite detailed compared to other countries but the incorporation of multicultural and Indigenous policies may not be spelt out or incorporated sufficiently. In Sweden, the influence of Swedish language and the textbooks in Swedish may influence any opportunity for difference to be incorporated adequately.

Meeting language differences in different ways

Bilingual education has been shown to have advantages (Cummins & Swain, 1986) if both languages are well developed. A primary discourse enables children to communicate, interact and identify with those closest to them. Outside of this safe and familiar setting, wider social life involves participation in a range of other secondary discourses which are acquired over time in the process of this participation. When a person comes across a secondary discourse that he or she has been unable to acquire through regular participation, then the ways of participating as a member of the new discourse community have to be learnt much more formally. Learning a second dialect (e.g. Aboriginal and Standard Australian English) entails learning two schema, as well as cultural schema (Malcolm & Farzad, 2005). In the process, blending becomes dysfunctional unless the language schema are established and explicit. Between 1972 and 1998 in the Northern Territory, there were bilingual schools but they were discontinued and replaced by schools teaching English as a second language but the change was not soundly based (Nicholls, 2005).

By contrast, 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 southern Swedish school, one team of teachers uses Arabic (the children's home language) for the first three years while other teams have students with various languages. Various school employees may speak the language of some of the students and when time permits the teacher and assistant meet to discuss the teaching plan. The assistants help with parent meetings and they use the goals developed for each child. As teachers stay with the same class for three years they know the

students and their families well and are concerned when children do not speak any home language well (Clarkson, 1992; Cummins, 1981).

However, what do these general points actually mean for the practices of teaching and learning of mathematics in multilingual classrooms? The following discussion arises from my own research and practice but many of the points will resonate with the work of teachers and other authors (e.g. Macgregor & Moore, 1995). When learning a new language, action verbs and nouns for objects generally come first so mathematical actions associated with mathematical words e.g. "add" help understanding when written, oral and observable behaviour/object are closely associated. Similarly counting, while a relatively easy task, must not just be rote but take note of language patterns and the principles underlying counting (Owens, 2006). Teachers should note if children's languages have diverse counting systems for different objects, if people or objects should not be counted, or if there are alternative ways of determining number besides counting. Examples can be found for Africa (Zaslavsky, 1973); PNG (Lean, 1993; Owens, 2001); USA (Dixon & Kroeber, 1907); Australia (Harris, 1991); Jannok Nutti, 2007). Grouping and equal grouping can be quite problematic because the cultural context suggests that sharing out is not done equally e.g. dividing up a pig at a feast (Owens & Kaleva, 2008b). Culturally one mathematical concept is used to determine another. For example, rain is measured in millimetres but one sees volume in the gauge whereas linear marks are used for volume on a measuring cup and length may be used when referring to volume in PNG (Owens, 2008b). Abstract nouns ("product, expression, value") should be assisted by instructional verb ("substitute to find the value").

Words that sound similar e.g. "side" and "size"; "estimation" and "evaluation", "triangle" and "rectangle" need careful pronunciation and experiential explanation. Some words make a concept difficult to understand, e.g. "6 lots of 5" for multiplication; "10 over 5" for division but other words have both a mathematical and general meaning such as "area". Another difficulty is that many languages have few if any prepositions or distinct ways of expressing relationships, position and direction (Owens, 2008). Difficulty with prepositions occurs in "5 more than 2, half of 10, 5 groups of 3, 10 by 3, 6 divided by 3".

Some concepts such as angle and fraction have many constructs and representations. These concepts require considerable language and experience for students to grasp. Many mathematical concepts are often explained by metaphors and these need explaining but colloquial metaphors should be avoided in multilingual classrooms. Furthermore, there are numerous hidden meanings in mathematical expressions. An example is place value but in many Australian classrooms, students can

count in an Asian language to strengthen the concept of place value by noting the language patterns that are not so evident in English. Equations and expressions are also fraught with hidden meanings and these need to be carefully unpacked for students so they recognise the intention of each consecutive line (Owens, 1999).

Some well known points need to be made but are frequently overlooked when trying to communicate with a person in their further language. Oral work by both teacher and students needs to be slow, purposefully repeated and not rapidly repeated. Sentences need to be simple. Students may play language games to get them to speak and listen to mathematical terms e.g. drawing what is written in the further language or speaking this language to explain the drawing. Students should be allowed to code (language) switch. Switching languages assists learning if knowledge is constructed rather than kept as unrelated ideas. Gaining understanding by playing with words and using bilingual facility will assist in constructing meaning. For example, a grade 2 student with English as a further language was able to develop the meaning of "bigger angle" by realising it did not mean "sharper" but the opposite "opening wide" (Owens, 1996). Students of the same language group may talk in their own language to explain to each other while students from other groups can try to explain as their gestures are often beneficial in helping another student. Students help each other and speak more mathematics. Oral learning is established through discussion (speaking and listening) during introductory whole class discussion followed by paired or group work prior to written communication (reading and writing) or class sharing. Visualisation (images in the mind from action on objects and pictures) provides a major context for oral learning when students describe these images.

Difficulty with a new language does not mean an inability to think at a high level. Students should be exposed to a range of tasks and not just easy ones, group work of various kinds, integrated activities that involve listening, reading, writing, and speaking about mathematical concepts, and problem solving.

Conclusion

In Sweden and Australia, funding has been provided to systems and schools to adapt schooling to the contextual needs of their students (e.g. Frigo & Simpson, 2000; NSWDET, 2007). Teachers also receive 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. Providing reading materials for small numbers of speakers of a specific language requires expertise and time to write and money to produce.

The synthesis of research and experience in this paper indicates that there are multiple approaches available for educational systems and individual teachers to meet the unique cultural contexts of their classrooms. In some cases, for example Sámi schools, have a cultural focus within the wider community context supported by government policies. Nevertheless, funds are needed for research, resources and professional development to have a Sámi focus in mathematics. 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. Programs are available for writing stories about the home communities in western NSW. However, teachers and researchers require a stronger awareness of cultural factors.

The issues relating to mathematics and language may not be 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 that could surpass the common classroom teaching approaches.

Effectively managing relationships and differences is a daily issue assisted by cultural knowledge and efforts to bridge the language barriers. These efforts may include teachers showing the community, parents and students that they value the home language and knowledge. Alternatively, intermediaries negotiate a solution, or informal and formal sessions are made available to parents.

At the teacher level, communication skills are paramount. Language, physical environment, the presence of members of the community in the schools, selection of activities, and teachers knowing the students personally in or out of school, all make make students welcome and able to make connections between home and school. 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 cultural knowledge, opportunities to express home knowledge and interests, and resources (written materials and teacher education) for meeting diverse backgrounds.

Teaching mathematics in a cultural context involves knowing and valuing the cultures of students and providing maintenance of the cultures of students. For example, teachers should ensure that cultural

mathematical knowledge is upheld and encouraged to assist learning school mathematics. This may involve teachers in research in their local communities to find the links between cultural knowledge and school mathematics and for communities, systems and researchers to guide this development.

Many values, both cultural and national, are learnt incidentally but among them must be respect and recognition of past, present and future as one. The national language including specific mathematical language must be learnt but multiple languages can have a positive impact on the learning of language and meaning. Some of these goals require both national and school strategies to promote the advantages of students' cultural diversity and to enhance students' mathematical learning.

This paper provides examples of communities and teachers striving for each of these goals (see other examples in Owens, 2008) and there is no doubt that in practice, there is a wide diversity of ways in which schools, systems and teachers implement these goals. By focussing on both Indigenous and immigrant situations in two countries, a breadth of understanding of these issues is grasped. The issues revolve around the key concepts of knowledge, relationships, values and purpose. For Indigenous communities, these are key concepts of the past which becomes the present and future. For immigrant families taking roots on new soil, these are also key concepts. Multilingual schools should incorporate the cultures of the students, extend the mathematical knowledges of teachers and students, and form learning communities enriched by the people and cultures of the community. To achieve these outcomes systems, policies and funds are required to support teachers who in turn will support their multilingual students.

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