Learning and Social Change

Reforming Mathematics Classrooms: A case of remote Indigenous education

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About the Authors

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Foreword

It is with pleasure that we publish the second working paper for the Griffith Institute for Educational Research. This paper is also the second paper from the Indigenous Education strand within the Institute. The Institute’s overarching theme of learning and social change resonates strongly with Indigenous Education. As a nation, those students whose families identify as Indigenous are frequently the most at risk of educational failure. This is a worrying situation for many Australians. Finding a way forward is one of the biggest challenges for education, policy makers and Indigenous communities. This paper is concerned with the teaching of mathematics. This area of schooling is problematic with the achievement gap for Indigenous students increasing (from their non-Indigenous peers) as they progress through school. Other factors compound the chances of success including the geographical location (urban, regional, rural or remote); health; economics and engagement. While these issues are not contained to mathematics per se, the fact that mathematics remains one of the high stakes curriculum areas often means it is not challenged as a field of study. Furthermore, the perception that mathematics is an apolitical body of knowledge that is above cultural boundaries makes it even more difficult to challenge. If the practices of mathematics can be changed so as to enable greater participation and success among Indigenous communities, then it is possible for other curriculum areas to similarly change. The focus of this paper is to provide a general overview of the landscape of Indigenous Australia, the implications for education, and to propose a pedagogy that offers potential for learners in diverse classrooms.

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Introduction

In this paper we seek to develop a case for the need for significant reform in the teaching of school mathematics. The approach that we propose is one that is sound for all students but most particularly, we are concerned with redressing the social and educational outcomes for Indigenous Australian students. On every measure, Indigenous students are more likely to perform poorly in comparison with their non-Indigenous peers. Not only is this a concern in the early years of schooling, but it is also recognised that the educational gap widens as students progress through schooling (MCEETYA, 2006). The problems are complex so a radical shift in approaches is needed. We believe that traditional methods of teaching where basic skills and reduced content levels are not the answer. What has been consistent in research for a considerable amount of time is that the traditional modes of teaching school mathematics do not create learning opportunities that foster deep and/or conceptual understandings of mathematics. This is for all students and yet such models pervade reforms, particularly for Indigenous students. Furthermore, teachers’ beliefs about a student’s capacity to learn exacerbate learning outcomes. As Gray (1999) has shown in the area of literacy, having high expectations of learning which translate into successful performance can be achieved when the appropriate scaffolding and environments are provided by schools and teachers. As such, this paper is a working document on how to engage with the challenge of ensuring Indigenous Australian students get the best chance to succeed in school.

Defining ‘Indigenous’

Prior to commencing this paper, we need to define what is meant by “Indigenous”. It is not a biological construct that once pervaded the social conscience of Australia. In contemporary times it is recognised as being an issue of identity and how a person identifies themselves as being Indigenous and how they are recognised by their communities as being a part of that community. As such, Indigenous people self-identify. It is also important to recognise that there is not one overarching Indigenous people but it is made up of many people from many different groups. There are people who live on the mainland of Australia as well as those who live in the Torres Strait. The diversity among Indigenous people as is as great as it is among any other groups of people. For this paper, we need to be able to express the focus of our writing in ways that will help support the coherence of the text. To enable this, we adopt the protocol of referring to “Indigenous Australians’ but are cognisant that this is a shorthand term that reflects a multitude of people, cultures and languages. It is not meant to devalue the diversity of Australian Indigenous people. Much like the debate that Bourdieu (1987) has noted around social class as a defining category, we adopt the same approach by proposing that it is what unites Indigenous people and makes them different from non-Indigenous people that helps to make a construct from which to talk about the issues around Indigenous mathematics education.
Background: The Context of Indigenous Education

In this section we outline the general life circumstances for Indigenous Australians. These conditions impact on the lived circumstances for Indigenous people and which, ultimately, impact on their education – either as students, families or communities.

Social and Economic Conditions for Indigenous Australians

As a group, Indigenous people make up about 2.2% of the national population, with approximately 410,000 people identifying as Indigenous on the 2001 census. The educational outcomes for Indigenous people cannot be separated from their lived worlds. The issues confronted by Indigenous Australians are significant. In terms of income, Indigenous people earn half that of their non-Indigenous peers (Appleyard, 2002). It is not uncommon for a family to have no employed adults within that unit thus making them entirely dependent on social security for their income. Part of the difficulty with employability is the lack of education, thus rendering many Indigenous adults without good levels of education or training and as a consequence, most vulnerable to the employment market.

In terms of health, Indigenous people have had no significant improvements in comparison with their non-Indigenous peers over the past few decades. For example, low birth weights still remain, hearing problems have not decreased, and infant mortality remains significantly higher than for the non-Indigenous population. Health problems, such as diabetes, are significant among Indigenous people with Indigenous people having a life expectancy 17 years shorter than the non-Indigenous population. The most vulnerable period of life for Indigenous people is in the period of 35-54 years of age where the death rates are 5 to 6 times than for non-Indigenous people. Indigenous people are 10 times more likely to have kidney disease and 3 times more likely to have diabetes than non-Indigenous people (Steering Committee for the Review of Government Service Provision, 2007).

Housing conditions are often very meagre with poor buildings and significant overcrowding. For example, in one case study of a community in Western Australia of 489 people there were 40 houses – of which 18 were condemned and 4 needed to be knocked down. In comparison with statistics in Sydney where the average occupancy is 3 people per house, there would have been 163 dwellings (Myers, 2007).

Indigenous people are disproportionately overrepresented in the justice system - either as offenders or victims. Indigenous imprisonment rates were 15 times higher than for non-Indigenous people with 77% of Indigenous people having
been in prison previously (Australian Institute for Criminology, 2006). For Indigenous youth, 52% of those in Juvenal detention centres were Indigenous. The youth Indigenous incarceration rate is 23 times that for non-Indigenous youth (Australian Clearing House for Youth Studies, 2008). In some cases, authors (Ogilvie & van Zyl, 2001) have argued that youth incarceration is at such a high rate that for many Indigenous people it is seen as a rite of passage. Such a view is, however, not without criticism in that it normalises the institution of Indigenous youth. Moreover, is a worrying trend that incarceration rates are increasing at a faster rate for Indigenous people than for non-Indigenous people (Wijesekere, 2001). In part, this increase could be due to self-identification thus skewing some of the reporting due to more Indigenous people identifying with their heritage.

Distribution of Indigenous People

From the 2001 census data, it was found that nearly 90% of Indigenous people live in major cities or inner regional areas. The break up of the location of Indigenous people is that:

- 30 per cent of Indigenous people lived in major cities, and 20 and 23 per cent lived in inner and outer regional areas, respectively. Nine per cent lived in remote areas and 18 per cent in very remote areas. (Steering Committee for the Review of Government Service Provision, 2007, p. 2)

When considering the distribution across the states, 30% lived in NSW, 27% in Queensland; 14% in WA; 12% in Northern Territory, 6% in each of Victoria and SA, 4% in Tasmania; and 1% in the ACT. These figures indicate that the significant distribution of Indigenous people is in urban areas. However, educational outcomes for rural and remote communities are compounded by the distance that students live from major urban or regional centres.

Education and Training

With the national benchmarks, the success rates for Indigenous students are alarming. In those states where there are considerably remote regions (Western Australia, South Australia, Northern Territory and Queensland), the scores are very different from those states where the Indigenous students are predominantly in regional and urban settings. It would appear that geo-location exacerbates differences in performance.

When performance is considered in concert with expenditure per student and teaching/student ratios, there is more cause for concern as it would appear that such variables are not correlated strongly with performance. For example, the expenditure on students in the Northern Territory for the 2002-2003 was $14709/student compared with $8017 students in Victoria (Lowe, 2006). Part of
these funding disparities must be due to the dispersed education provision in remote areas. Furthermore, when considering teaching ratios in 2003, in NSW the ratio is 17.3 to one whereas Northern Territory is 13.9 to one (Lowe, 2006). Such figures indicate that while considerable money has been allocated to education, the expenditure is not producing gains in outcomes. For governments, this is a particularly disconcerting. However, in economic analysis, Junankar (2003) has shown that the social benefit coming from educational expenditure is significant and that more money (not less) is needed for the education of Indigenous people if there are to be significant changes in the benefits to communities.

Attendance and retention are also concerning for Indigenous students. Only 22% of indigenous students are likely to complete Year 12 compared against 47% for non-Indigenous students (Steering Committee for the Review of Government Service Provision, 2007).

In terms of absenteeism for Indigenous students, there have been numerous studies on this issue:

Despite a lack of national school attendance data and a lack of consistency in the definition and measurement of non-attendance it is, nevertheless, clear from the literature that absenteeism among Indigenous students is markedly higher than among non-Indigenous students. Indigenous students also have higher rates of suspension and lower retention rates than non-Indigenous students (Bourke, Rigby, & Burden, 2000, p.1).

Such absenteeism and transience among schools reduces learning opportunities for Indigenous students creating gaps in the learning for many students. This is particularly difficult for a curriculum area such as mathematics where, for many teachers, there is a belief that learning follows a linear model. Where students are absent, it is believed that important concepts are not developed and thus reduce the continuity of concept development. However, such a model has been significantly challenged by new research.

**Hard-to-staff schools: Transience, Stability and Sustainability**

The staffing of schools in remote areas is a perennial problem and has been noted by Noel Pearson, a national Aboriginal Activist, as a problem that exacerbates the quality of schools, teaching and learning for Indigenous students. In a plan similar to that of the Teach First program in the UK and the Teach for America in the US, Pearson advocates a significant change in current practice so as to attract the most qualified and experienced teachers to work in Indigenous schools (Cape York Institute, 2007).
Many of the schools in remote and rural areas are staffed by graduate teachers. Sharplin (2002) cites figures where in Western Australia, 90% of graduates were placed in rural and remote settings and with similar figures of 87% of Queensland graduates similarly placed in these schools in the first two years of their teaching careers. While graduates may come with enthusiasm, they lack the experience and repertoire of skills to teach in these schools, and do not gain mentoring in their early careers due to the high numbers of similarly qualified teachers in the schools.

The big problems confronting schools in remote and rural areas is initially attracting teachers to the schools, and then the high turnover of staff with most teachers taking up appointments for short term contracts. The difficulties of attracting adequately qualified teachers in discipline areas are particularly poignant in the secondary school sector so that it is not uncommon for teachers to be compelled to teach outside their discipline areas.

Within this complex milieu, teaching quality programs of mathematics is a challenge. Any program must take account of the multitude of factors that impact on learning. However, such variables should not be seen as an excuse for the provision of impoverished or lesser learning experience. Rather, high expectations and quality learning environments have been consistently recognised as being critical to the success of students.
The Policy Context

The poor educational outcomes for Indigenous people in this country have been well documented in numerous government reports, academic books and papers as well as reported in the media. Looking back over the various National and State Government policies to Indigenous education in the last 40 years, it seems that there are few areas which have received as much government focus and funding for such little improvement. We believe that policies have been very slow to understand and thus address the barriers to Indigenous educational achievement, and that these issues have been more complex and difficult to tackle than has been acknowledged. In addition, the conflicting responsibilities between the Commonwealth and the states over Indigenous policy have demonstrated the failure of such arrangements in addressing the needs of Indigenous peoples and students (Beresford, 2003). As has been detailed above, the educational outcomes for Indigenous people have been significantly behind that of non-Indigenous groups for a very long time. While there has been some overall improvement, the gap is far from closing. In fact, in recent years, evidence suggests that in some areas it has widened further (MCEETYA, 2006). The aim of this section is therefore to provide a brief outline of some of the major Federal policy approaches over the last 20 years that have led up to the current situation. We acknowledge the various policy histories of the states but feel that to wade through such varied and contested terrain would detract from the main arguments of this paper.

The history of Aboriginal educational policy in this country is one that has been characterised by forces of racial inferiority, segregation, assimilation (Beresford, 2003). We see the continuing poor educational outcomes for Indigenous people in this country to be a major human rights issue and as the recent Social Justice Report (2007) outlines, measures such as the Northern Territory Intervention raise serious concerns about the consistency of such legislation with human rights standards. This is not to say that tackling issues of family violence and abuse is not important. It is. However, there needs to be effective participation of Indigenous peoples in decision making that affects them (Social Justice Report, 2007). This active participation of Indigenous groups needs to be an essential aspect of any reforms in Indigenous education and has only received attention as an issue in recent years.

The 1967 referendum marked a significant turning point in government approaches to Indigenous issues and education as this signalled the beginning of a period of Commonwealth activity into Indigenous education. It therefore wasn’t until the 1970s until the poor state of Indigenous education became apparent (Beresford, 2003). The 1971 Census and research by Watts (1978) highlighted issues of remoteness, truancy and attendance, culturally inappropriate curricula, and racism as contributing factors to the poor educational achievements of
Indigenous students. While this research was beginning to paint a picture of what was happening to Indigenous students in schools, both National and State policies were unable to effectively address the needs of these students in any real way.

The first significant policy into indigenous education came with the Report of the Committee of Review of Aboriginal Employment and Training Programs (Miller, 1985), in which links were made between Indigenous disadvantage and education and employment. Following this came the setting up of the Aboriginal Education Policy Task Force in 1988 which was to report of all aspects of Indigenous education. The aim of the task force was to review research and reports into Indigenous education and provide recommendations for future policy approaches. This increased level of activity into Indigenous education culminated in the National Aboriginal and Torres Strait Islander Education Policy (NATSIEP) in 1990. This policy was significant for a number of reasons. First, the policy attempted to launch a process of involvement of Indigenous communities in the development of policies and programs. This can be seen through the policy’s five key objectives:

- To achieve equity in the provision of education to all Aboriginal children, young people and adults by the year 2000;
- To assist Aboriginal parents and communities to be fully involved in the planning and provision of education for themselves and their children;
- To achieve parity in participation rates by Aboriginal people with those of other Australians in all stages of education;
- To achieve positive educational outcomes for Aboriginal people in school and tertiary education;
- To improve the provision of education services across the nation at the local level.

It would be hard to dispute the intent and sentiment of such aims, but there was little, if any real understanding of the sorts of barriers education systems would face trying to achieve these aims (Beresford, 2003). Luke et al. (1993, p. 148) succinctly describe some of the key limitations of this policy:

Throughout, the discourses on the complex causes and consequences of Aboriginal educational programs are subordinated to a linear model of cost-efficiency delivery. Yet an emphasis on performance indicators here has the force of deferring and glossing questions about the structures, experiences, and conditions of schooling…To put it simply, they may just signal increased participation in a systematically disempowering education.

While acknowledging the limitations of the policy, it is important to remember that it provided a key shift in thinking towards recognising the importance of the inclusion of local groups to become actively involved in decision making in local sites, although even to this day, more needs to be done in consultation with, rather than to Indigenous groups and communities.
After a period of review of the programs and goals established in NATSIEP and subsequent programs, in 1996, the National Strategy for the Education of Aboriginal and Torres Strait Islander Peoples marked the coming together of the Commonwealth Government and MCEETYA to focus on educational outcomes rather than financial inputs, which had been the previous focus for a number of years. In 2000, the National Indigenous Education Literacy and Numeracy Strategy (MCEETYA, 2000) marked a ‘new strategy that now openly set out to achieve literacy and numeracy standards for Indigenous students that match those of non-Indigenous students. This could possibly be in part response to the 1990 report which aimed for equal achievement levels for all Australians by the year 2000! The rhetoric of Government reports and policies since 2000 has been one of expectations for increased achievement levels and the increasing of the pace at which outcomes for Indigenous students will match those of the rest of the Australian student population. According to a Queensland Report in 2004 (MACER, 2004), one of the significant shortcomings of previous policies in Indigenous education in this country is due to the lack of collective responsibility and accountability frameworks in the various state and Federal systems. The report states that:

The sub-committee concludes that a failure to clearly articulate the accountabilities of education officers and teachers for improved Indigenous student outcomes is the major silence in previous Indigenous policies (2004, p. 8).

This report is referring to not only policies in Queensland but also other states in addition to the Commonwealth level. It seems that despite an abundance of policies at both the state and Federal level, the educational outcomes across most benchmarks have not only failed to increase but have even declined from 2004-2005 according to the National report on Indigenous Education and Training 2005. Key issues such as intergenerational disadvantage, combined with schooling practices that work to marginalise Indigenous students continue to plague the educational systems in Australia. In response, in this paper, we emphasise localised resistances to these systemic practices through notions of productive leadership (in a later section) and reforming pedagogy, particularly in the teaching and learning of mathematics.
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Theoretical Framing of Reform in Mathematics

The systemic failure of Indigenous students in Australia, and internationally, is a problem of significant importance. Coming to understand why so many students are systematically performing poorly on measures of performance requires radical reconceptualising of the teaching of school mathematics if we are not to repeat the errors of the past. For many “innovations” in mathematics, the practices of the past are embedded in the new so that the reform is simply a disguised or, even worse, a deficit model of learning. As we will show in this paper that the practices that are valued within the school system work to exclude, marginalise and reify cultural differences to the detriment of indigenous learners. Within this framing, “learning mathematics” is not an individual characteristic, but rather a tension within the processes which indigenous students encounter as they come to learn school mathematics and those that they bring to school. To theorise this tension, the theoretical project of Pierre Bourdieu is most useful, and in particular, his notions of field, practice, habitus and symbolic violence are particularly pertinent to framing the “learning mathematics” faced by Indigenous learners as they confront the world of school mathematics.

Understanding “Learning Mathematics” as a Structuring Practice

In this paper we seek to develop a position on why learners of Indigenous backgrounds are less likely to be successful in the study of school mathematics. Rather than see this as an individual characteristic, we propose that the practices within which mathematics is taught/learned by students are structured in subtle and coercive ways that facilitate the chances of success so as to favour particular groups of students and to marginalise Indigenous students (along with other disadvantaged groups). Students most likely to be successful in the study of school mathematics are generally those from the dominant culture. Teese (2000) has shown how the practices of school mathematics correlate strongly patterns of social structures. Taking such a perspective makes it possible to better understand the systematic exclusion of Indigenous students from participating in the field of mathematics. Such a process enables a richer theorisation of the reproduction of power through school mathematics and why it takes considerably more effort for teachers and learners if students from these backgrounds are to be successful in their study of this discipline area.

In framing the paper through the use of Bourdieu’s constructs, we plan to show how the field of school mathematics has particular practices that seek to facilitate the growth of a mathematical habitus. This habitus may require significant reconstitution of the primary habitus of Indigenous students for whom the practices reified in the field of school mathematics are at loggerheads with the
primary habitus brought from the home environment. The practices of the field of mathematics can be seen in written texts such as curriculum documents, textbooks; through assessment practices such as external examinations, school-based assessments or incidental assessments such as teacher observations which are then reported in formal documents such as reports or through personal interactions with the student; and through pedagogic practices such as ability grouping, small group work, teacher interactions and so on. It is not possible to consider each construct without considering the other constructs simultaneously. The habitus only can have capital within a particular field. For example, within the field of Indigenous knowledge, the spatial habitus of an Indigenous person may include knowing how to map the land within cultural/historical markers. Such a habitus may convey particular status (and hence capital) but within the field of mathematics education, such ways of mapping the land hold no/little status and hence cannot be exchanged for forms of capital within the field of mathematics education. Similarly, the practices within the field of mathematics education are seen as valued (or not) within that field. These practices are shaped by the participants within the field (generally those with the capital of the field). If one considers the ways in which what is seen as legitimate knowledge (such behaviourism or constructivism) within the field at a particular time, then those with the habitus of that time may exchange their knowledge for forms of capital (such as promotions or grants). Fields are in a state of flux where they form and reform where products (knowledge, taste, and ways of thinking working acting) are re-valued so that the forms of capital are undergoing change over time.
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In coming to understand the field in relation to the success of Indigenous students becomes possible using this tripartite model. When the habitus of Indigenous students is different from what is seen as valued (as per the practices of the field), then there is little chance for success for the students (as recognised through the accumulation of capital). The role of education then becomes one of critical inquiry into the barriers for learning for students (reconstitution of the primary habitus) and the constitution of the practices within the field so as to accommodate learners within the field or to reconstitute the field in ways that recognise the habitus of indigenous learners so that the practices of the field become challenged to accommodate new forms of knowing and practice.

Drawing on Bourdieu’s notions of capital and symbolic violence, the practice of school mathematics can be seen as one where the ways of thinking, acting, talking and working have become reified through documents and other objective structuring practices that define what is seen as legitimate knowledge. Those who have such knowledge, and dispositions to acquiring and displaying the same, are more likely to have considerable power within this field. That is, if a student is able to display what is seen as valued knowledge within the field, then they are more likely to be described as successful learners. Consider the young child who comes to school knowing how to count, classify, articulate names of geometric shapes and other mathematical objects. The pre-school familial practices have enabled the child to acquire particular forms of knowledge that are valued within the practices of schools mathematics. When the child displays particular counting skills for example, then the teacher ascribes the child to be an effective counter. However, the familial circumstances within which a child experiences some fundamental learnings are very much shaped by the culture of the family. Through this early socialisation, the child has developed a particular habitus that predisposes him/her to act in particular ways. This habitus now acts as a medium through which the child displays and acquires new forms of knowledge.

Where the primary habitus that the child acquired in the early years of life aligns with the practices he/she will encounter upon entering school, then there is greater chance for success within that secondary context. What can be seen in the early years of schooling is that a child displays the forms of knowledge that the teacher sees as valued and ascribes certain general characteristics to the child. Conversely, where a child does not display the characteristics that are seen to be integral to school mathematics, then the child is most likely ascribed as being deficit in some way or another such as being a non-counter or not recognising numerals, colours or shapes. However, acquiring such knowledge is often linked to the home experiences. Middle-class parents are more likely to interact with their children in ways that are similar to the interactional patterns of schooling, such as posing pseudo-questions (Heath, 1983) or using particular language
forms such as the use of binaries (more and less) (Walkerdine & Lucey, 1989) which positions the child as school-ready prior to their entry to school.

The familial experiences position the child prior to school in ways that are critical to their potential success in school. For example, in many Indigenous communities or remote communities the need for number is limited so that out-of-school experiences are limited. The child enters the school with a restricted repertoire of number experiences and language. Conversely, Harris (1990) has shown Indigenous students enter schools with a rich repertoire of spatial knowledges but these are not part of the school mathematics curriculum. Similarly, Willis (2000) has argued that very young Indigenous students may be able to subitise but do not demonstrate those counting skills that are part of the early years curriculum (one-to-one correspondence, rational counting, etc). In this way, the entering habitus of the students is different from the skills and dispositions that are embedded in the school curriculum. The practices of school mathematics thus valorise the entering habitus of some children and deny (and marginalise) the habitus of students whose out-of-school experiences are different from those reified in the curriculum. This process effectively differentiates learners on the basis of their primary habitus in ways that are coercive and effectively only lines of race, culture, language and gender. When framed this way, learning difficulties are not part of a deficit of individuals or part of an inherently individual nature but along structured and systemic lines that help to support the status quo.

In the remainder of this paper we draw on Bourdieu’s notion of symbolic violence as a way to frame the hegemonic role of school mathematics to better understand the difficulties faced by students whose backgrounds are not those valued by the curriculum (where curriculum is seen in it broadest sense). For Bourdieu, symbolic violence is a process where the victims are complicit in their domination. Rather than overt violence, symbolic violence is where a “body of knowledge that entices the dominated to contribute to their domination by tacitly accepting, outside of any rational decision or decree of the will, the limits assigned to them” (trans in (le Hir, 2000, p.135). This approach is not to place the blame on the victims (which has been a criticism of the construct) but as a tool through which the processes of domination can be better understood and that through this understanding, a first step is made towards their elimination.

Teaching Indigenous Students: An Act of Symbolic Violence?

The current modes of teaching of mathematics to Indigenous students can be seen to be an act of symbolic violence when using a Bourdieuian framework. Such an approach implies that learner and teachers are complicit in the reproduction of dominant forms of knowledge to the detriment of marginalised groups. Through their complicity in what is seen to be an apolitical act, dominant
groups are able to maintain their status within the social order without any need for overt force or violence. Through the processes implicit in the act of teaching, dominant forms of knowledge and knowing retain their hegemonic role in preserving the status of the dominant groups. This is to the detriment of Indigenous knowledges and ways of knowing. For Bourdieu, this is summed as follows:

The theory of symbolic violence rests on a theory or belief or, more precisely, a theory of the production of belief of the work of socialisation necessary to produce agents endowed with the schemes of perception and appreciation that will permit them to perceive and obey the injunctions inscribed in a situation or discourse (Bourdieu, 1998, p.103).

But symbolic violence does not occur without considerable preliminary work to be undertaken. In the case of mathematics, there have been centuries of repression of forms of knowledge such as those of the Islamic and Asian contributions to mathematics (Joseph, 1991) so that the legitimate knowledge of the curriculum is that of a western orientation and where other forms of knowledge are replete from the knowledge base. Through this process, a reinforcing of Western ways of knowing have become the taken-for-granted forms of knowledge. Similarly, the ways of teaching have become accepted as the dominant modes of pedagogy. Considerable work in the reform of school mathematics has been undertaken but as Gutierrez (1998) argues, along with many other mathematics educators, the change process in mathematics is very difficult. This reflects an assumption about the taken-for-granted ways of teaching mathematics that have become resistant to change despite considerable research to show that such practices do not meet with success (e.g. Boaler's extensive cross cultural work in the UK and USA, (Boaler, 1997a, 2008).

For a symbolic act to exert without a visible expenditure of energy, this sort of magical efficacy, it is necessary for prior work - often invisible, and in any case forgotten or repressed – to have produced, among those who submit to the action of imposition or injunction, the dispositions necessary for them to feel they have obeyed without even position the question of obedience (Bourdieu, 1998, p.102-103).

Thus, for us, much of the teaching of school mathematics can be seen as an act of symbolic violence when undertaken in many contexts – Indigenous, working-class and so on. This is particularly the case where cultural forms of knowing are not an integral part of the curriculum.

The National Inquiry into Rural and Remote Education - 'Emerging Themes' suggests Australian Indigenous people ‘have become alienated from the school
system’. (2000, p. 58). In part this is due to the lack of synergies between the parents’ and communities’ expectations of school and what schools offer. When framed within Bourdieu’s project, the difference between the culture of school mathematics and the culture that the students bring to school is not simply an apolitical act, but one where the misrecognition of the two cultures enables mathematics to maintain its power base and for those who fail to assume something inherent in their own ability and thus become complicit in the production of their own oppression. This, as Bourdieu noted above, it done in a way that remains hidden to those participating in the act. Within this framing, the truancy that is seen to be an endemic issue among Indigenous students (and noted in earlier sections of this paper) may be a reasonable act of resistance to the symbolic violence being enacted upon Indigenous people.

Where the complicity between beliefs and practice becomes apparent is when teacher frame for lack of success on factors such as attendance, health, transience, family expectations and so on and then offer an impoverished curriculum for students. But this need not be the case. In the area of literacy Gray (1999) has argued that such factors should not be seen as an excuse for poor performance of Indigenous students and that, with appropriate scaffolding, teachers can offer a very rich literacy program for Indigenous students. Similarly, there is every potential for Indigenous students to come to learn mathematics provided there is adequate provision made to scaffold students’ learning to enable a bridging between the two cultures. In mathematics, there have been numerous studies that have shown that students from disadvantaged backgrounds can be offered a very rich mathematical curriculum and have success (Boaler, 1997b, 2008). However, as Boaler’s comprehensive work has shown, the learning environments are critical to the success of these students. Transplanting a traditional pedagogy into a classroom where there are considerable disadvantaged students offers little chance for success. Rather, as her detailed study of “Railside” has shown, by radically changing pedagogy to meet the cultural dispositions of students while offering a rich mathematical learning, students can succeed in school mathematics.
Mathematics Teaching as Symbolic Violence

Much of the current teaching of mathematics involves the transmission of knowledge that is inherently that of the dominant classes. There has been a strong criticism of the hegemonic forms of knowledge that are embedded in school mathematics. Similarly, the ways that different teaching approaches are organised can similarly create difficulties for learners when their cultural knowledges and ways of knowing are not part of the repertoire of teaching practices. The need for an approach that is culturally inclusive has been recognised by some educators:

Teaching methodologies that recognize and build upon the pupil’s cultural heritage and the specific ways in which children are taught to process information can play a critical role in addressing this concern. Inclusive instructional strategies that recognize and embrace this cultural dimension can help teachers ensure that all students in mathematics classrooms become successful learners (Varghese, 2007, p.2).

Teaching School Mathematics in Remote Indigenous Contexts

Many of the teachers working with Indigenous students are non-Indigenous and are very early in their teaching career. Frequently, the teachers in remote schools are often in their first teaching position.

The teaching practices observed in schools often align with the rote, drill and skill methods. In their work in Queensland schools, Warren et al. (2005) reported that the teaching approaches they observed could be seen to be of this form and were formed by narrow views of what was seen as appropriate knowledge and ways of teaching for indigenous students. Adding to this Howard and Perry (2005): reported that teachers failed to take into account the particular needs of Indigenous children in classes and were ignoring their cultural needs:

Even though there were significant numbers of Aboriginal children in their classes, teachers were not considering them and appreciating their cultural needs in the mathematics classroom (Howard & Perry, 2005, 158).

Other researchers have documented the phenomenon that Indigenous students can learn mathematics and that the performance on test items is not due to a deficit in capacity but rather to educational and social factors (Boulton-Lewis,
1990), thus debunking the mythology of inherently flawed cognitive skills for Indigenous learners.

The literature suggests the current practice in the teaching of school mathematics to indigenous students:

- Follows a very lock-step, rote, drill and skill approach
- There is little recognition of the cultural difference Indigenous students bring to the classroom – either as learners or as bearers of different knowledges
- Indigenous students are often rendered invisible in the accounts made by teachers as they talk about practice, even when there are significant numbers of indigenous students in their classrooms.

Indigenous Knowledges and Background Mathematics

There are two dominant ways of thinking about incorporating Indigenous mathematics into school mathematics. One alternative is to preserve the hegemony of school mathematics by searching for mathematics in Indigenous activities (akin to the ethno-mathematics approaches) and to suggest that such activities provide evidence that Indigenous people are able to undertake forms of mathematical understandings and hence are capable of learning school mathematics.

There is often a sense that Indigenous students do not bring much mathematical understandings or knowledge to the school context. In her comprehensive work of Indigenous communities in the Northern Territory, Harris (1990) reported Indigenous understandings of time, space, and money from the perspectives of the people. Similarly, in his early work searching for mathematical universals, Bishop (1988) argued that there a number of mathematical activities found in every culture. However, this work was framed by a Western perspective thus rendering some forms of knowledge to a western mathematical standpoint. Other approaches have sought to investigate activities undertaken by Indigenous people in order to unpack the mathematics involved in the activities and then to use such activities as the basis of curriculum activity. An example of this type of work can be seen in examples of card games (Baturo, Norton, & Cooper, 2004) that are common to many Indigenous communities. Collectively, such approaches take the Indigenous activity and search for the Western mathematics within that activity. Dowling (1991) has convincingly argued that such approaches reinforce the (high) status of Western mathematics while subjugating the Indigenous activity at the expense of Western mathematics.

Conversely, Watson (1987) worked with the Yolgnu people in Arnhem Land in Northern Territory to develop a both-ways education program. Working with the Yolgnu people, they developed a mathematics program that recognised
both Western and Indigenous ways of knowing as legitimate. In this work, for example, the ways of understanding the land (mapping the landscape) were undertaken through both school mathematics and Indigenous approaches. Such an approach seeks to develop border crossings between one culture and another with neither culture being fore-grounded but recognising that each has particular strengths. Indeed, it could be argued that incorporating Indigenous knowledges into school mathematics may enrich the experiences for all students. In an international context, others have approached border crossings in this way. For example Ezeife (2002) illustrated the power of building bridges between the culture of the students and that of school mathematics.
Recognising the Need to Reform School Mathematics

Lowe (2006) suggests that there are five elements to making for a successful change in schooling. These are adequate infrastructure to support the reform; strong leadership; quality programs (in her case, literacy); school-wide programs; and community involvement. In so many reforms, the importance of leadership has been an integral part of the success of any reform initiative. As such, we will now focus on the literature on leadership, particularly on the models of leadership and their relevance to Indigenous education. As we have noted elsewhere, the value of leadership within reforming schooling is critical to sustained practice that will enable greater engagement and success in education (Zevenbergen, Walsh, & Niesche, 2009 in press).

Leadership

Before we discuss the potential of a reform mathematics, we recognise that despite having the best possible innovation, the uptake of any reform is strongly influenced by leadership at the school level. In the following section, we define leadership very broadly and do not confine it to the principal who is often seen as the leader of a school.

We include a section on leadership in this paper as we view good educational leadership to be crucial in reducing the gap between the educational achievements between Indigenous and non-Indigenous students. From our work in Far North Queensland (Zevenbergen, Delaforce, & Niesche, 2008) we found that despite the best intentions, the rollout of policy is strongly influenced by leadership at the school level. While there is no direct link between leadership practices and improved student outcomes, leadership must be considered an essential a factor in making hope practical for Indigenous students (Lingard, Hayes, Mills & Christie, 2003). Lingard et al. (2003) argue that the task of school leadership is to lead learning by creating the and importantly sustaining the conditions which not only facilitate social change but maximising social and academic learning. As such we argue that leadership in schools must tackle issues of curriculum, pedagogy and assessment as fundamental issues of concern in the day to day business of schooling. Our approach to these particular issues is discussed in later sections of this working paper.

The term leadership is a heavily contested one and discourses of leadership are now largely ubiquitous given the breadth of both conceptual and research literature (Gronn, 2003a). There has been a huge growth in the business of leadership studies in recent years as it seems that the term ‘leadership’ has become privileged over other terms such as management or administration.
Leadership has often been associated with notions of influence, power, authority, control and supervision (Yukl, 2002), although certainly recently the term leadership has gained significant favour. It is easy, when thinking of the term leadership to immediately conjure up images of ‘great men’ such as Gandhi and Nelson Mandela, or ‘infamous men’ such as Hitler or Stalin. To understand leadership, Gunter and Ribbins (2002) argue that leadership needs to be understood as not just tasks and behaviours, but understood though the gathering of professional experiences within different contexts coupled with a theorising of agency and structure. In this section we use the work of Lingard and Christie (2001) and Lingard et al. (2003) to conceptualise leadership as a form of influence that can exist at any point within (or outside) an organisation, and not just considered synonymous with the head of an organisation or a particular individual. More specifically, leadership should be seen as being “practised by many teachers, principals and parents in a range of educational sites and in a number of informal as well as formal administrative positions” (Blackmore, 1999, p.6). This view of leadership as being exercised at all levels of the school is synonymous with distributed, dispersed or parallel leadership (Crowther et al., 2000; Crowther et al., 2002; Gronn, 2002, 2003b, 2006; Spillane, 2006). Thus, leadership is not exclusive to any one position, and certainly does not only revolve around the position of principal. Leaders can emerge from anywhere within the organisation. It must be noted, however, that the principal is usually constructed as the centre of control in the school by numerous leadership and schooling discourses. The principal is placed in the position of ‘head’ of the school, and such structure of schooling makes it very difficult for others to participate in decision-making processes if they are not within this hierarchical structure. As stated by Lingard et al.:

Discourses of schools constitute principals as their ‘heads’. Indeed it is difficult to imagine schools without principals because it is common for the administrative heart of the school to be clustered around the principal’s office and for this to be the point of interface between the school and the community. The principal’s office is also commonly constituted as the locus of control and discipline and there is also a line of command designed to ensure the seamless transfer of power in the event of the principal’s absence (2003, p. 141).

Kotter (1990) stresses the importance of leadership as being fundamental to bringing about change. In doing so, Kotter is forging a particular place for leadership in the field of management studies, that is, working on a dualism that sees management as ‘running things’ and leadership as ‘changing them’. While Kotter’s perception of leadership is very top-down oriented, his emphasis on change can be useful, as not only are principals expected to enact change within their school but also to deal with and manage constant changes within complex
policy contexts. The principal’s position is important as he or she is the only one in the school who actually has knowledge of the organisation as a whole, and as a result, has to deal with the boundary issues of the institution. Thus while Fullan’s sentiment of, “every person is a change agent” (Fullan, 1993, p. 39) is important, it does not reflect this particular position of principals within the organisation structure. It is therefore crucial that leadership is understood in terms of an ongoing relationship between participants, not just in terms of a great visionary individual and not just as a top down one way flow of authority. In order to avoid this type of dominant and pervasive discourse, it is necessary to examine the contextual factors upon which leadership discourses are constituted. This links to the arguments of both Gronn (2003a, 2003b) and Blackmore (1999) about avoiding a view of leadership that sees it as something exceptional but rather to see it as everyday practice. Further to this, Christie and Lingard argue that “leadership needs to be understood in terms of the complex interplay of individual, organisational and the broader social, political and economic contexts” (2001, p. 19). This type of approach is complex, yet necessarily so in order to adequately convey the multitude of factors at work.

Similarly, in a search for new perspectives on leadership, Sinclair (2004, 2005) and Sinclair and Wilson (2002) argue that leadership must be understood through its political, cultural and historical contexts. Dimmock (2003) and Dimmock and Walker (2005) have also emphasised the importance of culture in educational leadership. Initiating a study of leaders through their “complex cultural roots”, Sinclair and Wilson (2002, p. 2) provide an illuminating analysis that may diffuse the need to conform to traditional leadership stereotypes. Exploring leadership through a discourse of complex cultural roots is an avenue of study that takes the notion of leadership away from the dominant discourse that constructs leaders as white, male and with exceptional visionary purpose. Similarly, Sinclair’s work (2004), through personal narrative, emphasises a view of leadership that moves away from objectified, disembodied, de-gendered and positivist approaches.

These types of contributions to the field promote leaders as coming from a variety of different backgrounds, whether it is on a basis of gender, ethnicity, race, or socio-economic factors. We believe that context needs to be more strongly recognised in approaches to leadership.

There have been a number of shifting attempts to pin down the discursively and polysemic notion of leadership over the years. Such discursive constructs as trait (Stodgill, 1948, 1974; Goleman, 1995), situational and contingency theories (Hersey & Blanchard, 1974), transformational (Burns, 1978; Bass, 1985; Leithwood, 1992; Leithwood, Jantzi & Steinbach, 1999), distributed leadership (Gronn, 2002, 2003, 2006; Spillane, 2006), authentic or instructional (Hallinger, 2003; Southworth, 2003), moral (Fullan, 2003), and sustainable (Hargreaves & Fink, 2003), have not been able to fully resolve the quest for a definition of leadership. Nor do we aim to do this. The notion of generalising across place,
time and space is one that does not take into account the specific contexts or ‘thisness’ (Thomson, 2000, 2002) of the school setting as well as the complex interplay of power elations at work within schools and across educational systems. As Christie and Lingard state:

Educational leadership involves storied individuals, within the organisational contexts of schools as institutions for systematic teaching and learning, at particular times and places, while also recognising that there are multiple and contingent factors which come together in the creation of educational systems and schools (2001, p. 8).

All of the leadership models listed above do not allow for the production of context specific principal subjectivities which are formed through multiple and competing discourses. A result of this de-contextualising of leadership is the drawing up of leadership frameworks based upon standards and competencies which leaders much exhibit. Such leadership by design frameworks (Gronn, 2003b) emphasise the search for distinctive leadership roles and qualities which we believe to be problematic. Thus we are not searching for the characteristics of what makes a good leader in Indigenous schools or communities but rather emphasise the importance of providing storied and textured examples of leadership in Indigenous schools and communities that we can better understand the multitude of complex factors at play in the day to day lives of educational leaders (Niesche, 2008).

Indigenous Communities and Leadership

It is important to note that the above discussion around leadership is prefaced around western notions of leadership. That is, notions of leadership from Australia, Britain and the USA. What is implicit in these theories, and what we consider to be largely problematic, is the idea that such notions can be transported and legitimated across homogenous educational systems (Fitzgerald, 2003a, 2003b). While there has been significant work undertaken in regards to gender and leadership (Blackmore, 1999; Collard & Reynolds, 2005; Limerick & Lingard, 1995; Ozga, 1992; Shakeshaft, 1987), there still needs to be more work examining how leadership can be theorised in terms of ethnicity and in particular amongst Indigenous Australians. This does not simply mean the ‘adding on’ of issues of ethnicity to existing leadership structures but actively valuing and negotiating difference. As Blackmore (1999, p. 203) argues, leadership diversity is about leadership for and not necessarily of diversity.

Adopting a number of values drawn from Indigenous perspectives, the report from the Australian Institute of Aboriginal and Torres Strait Islander Studies (1998, pp. 15-16) promotes:
• Initiation of the role of the leader and authority to speak and represent indigenous communities;
• Benefits and connectedness to indigenous communities by their leaders and wider benefits through interaction with non-indigenous groups;
• Representation and articulation of issues for and within Indigenous communities and links with non-indigenous groups;
• Legitimation of authority from indigenous communities as a core credential for leadership; and
• Accountability to indigenous communities for the actions and activities of leaders.

Such principles that include multiple voices must be central to educational leadership and not simply an ‘add-on’ to existing normative leadership models and frameworks.

Case Study: Pine Rivers Community School¹

The example of the Pine Rivers Community School in Queensland provides an interesting example of leadership of and within an Indigenous Community school that adopts a similar approach to the points listed above. With the current debates in the media concerning ways forward for Indigenous education in this country, Pine Rivers is providing a successful model of a school embracing Indigenous values and ways of being coupled with community ownership of their communities’ learning outcomes. One of the purposes of including this case study is that:

Narratives of the real life of schools attempting to change, narratives based on empirical study that do not seek to create ‘best practice’ and models, but rather tell particular stories that exemplify potentially useful principles for ways of working, have some hope of connecting with the reform efforts of other real life schools (Thomson, 2002, p. 189).

Not only does this school signify a struggle for Indigenous peoples to obtain community control and ownership of schools and other educational facilities, but also for understanding the importance of cultural beliefs and practices in the children’s development (Downey & Hart, 2000).

Pine Rivers is an independent community-based school in a metropolitan area of Queensland. It has been operating since 1986 and has progressed from a focus on primary school to now incorporating both high school and community based

¹ A pseudonym has been used for privacy reasons.
education services. For its first ten years the school was located an in inner city area in a disused Catholic primary school. At this site there were only three classrooms and almost no playing areas for the students. The school then moved to its current location where it is now more able to suitably fulfill the needs of the children. The school is the only community based independent Indigenous school in its area. Over the years the school has responded to the needs of the students by implementing a number of programs and strategies to enable a successful schooling experience for the students. For example, the school runs a private bus system to transport the students to and from school each day, often from all over Brisbane. The school runs a nutritional program whereby the students are provided breakfast, morning tea and lunch so that they are ensured regular meals during the school day. The school also runs a health out-clinic to monitor general health and wellbeing as well as a learning skills centre that caters for the wider Indigenous community, including adult education. In terms of staff, it is school policy to ensure a large percentage of teaching staff are of Indigenous background. There is also a full-time child and family support worker as well as a speech therapist/pathologist. These are just some of the important services offered at the school to meet the wide ranging needs of the students and Indigenous community in general. The school maintains a very low fee structure for parents as a significant percentage of parents receive welfare benefits and/or are in low income employment. This is an example of the commitment the school has in achieving the participation of Indigenous children in primary and secondary schooling.

The role of the community has also been of particular importance for the school and has provided significant emotional and financial support for the school and the tutoring program. The Aboriginality of the students, staff and school is something that is celebrated and is part of the school’s philosophy. In addition, the school’s vision states, “In respect of our peoples, our cultures, our land, we foster an inclusive learning environment which promotes empowerment, identity and success through education” (Pine Rivers School Handbook, 2008, p.1). The literacy program run at the school is funded through The Indigenous Tutorial Assistance Scheme (ITAS) and was started in 1994 due to concerns over the very low levels of literacy among its students. The program is closely aligned with the view that:

Schools largely operate within a system of communication that is suited to life in a white Australia context whereas Aboriginal students usually come to school equipped with an Indigenous worldview and context including history, culture, politics, economics, sense of time and space and spirituality (Malcolm, Kessaris & Hunter 2003: 93).

The program was designed with the assistance of a speech therapist to address needs of students with a particular focus on improving reading and associated literacy skills in ways that are culturally appropriate for Indigenous students. This
is important as issues of literacy in this school are not portrayed as a ‘holy grail’ for literacy instruction but rather a program that intimately links literacy with the students’ cultural understandings, that is, their communities, languages, cultures and discourses (Freebody & Luke, 2003). While this program is focused on literacy, there are certainly a number of principles central to the program that could be applied to models of reform pedagogy across different curriculum areas. The importance of highlighting this program within this case study is an example of the school’s leadership working closely with curriculum and pedagogy, along with not just recognition of diversity but working with multiple world views. The day to day running of the literacy program is also handled by the program coordinator, so the dispersal of leadership within the school needs to be highlighted.

The entire Language and Literacy Program is comprised of the following components:

1. The assessment of each student’s language and literacy skills.
2. Designing a program to meet the specific needs of each student.
3. Advice to the teachers from the program co-ordinator and tutors regarding each student’s abilities and needs.
4. The employment of suitable tutors to implement the program on a one-to-one basis with the children, and training of tutors where necessary.
5. A regular monitoring of the program by the co-ordinator, speech therapist and tutoring staff.
6. An annual review of the student’s performance to determine their progress in the program.

One of the central tenets of this program is the understanding that many of the school’s students speak “Murri English” and that the program aims to broaden their options by teaching them to use and understand Standard English as well. Thus the emphasis is not to replace but to augment their language skills. The students are explicitly told that their language that they speak is just as valuable as any other and that there are different ‘languages’ used in different places, for example, in the school classroom there is a certain type of English that teachers expect kids to use in both written and spoken form. This is where the community based nature of the school is important as the school places a very high importance on maintaining cultural traditions. One of the benefits of the one on one instruction is that as well as promoting academic skills, the tutoring programme provides every child with a potential mentor and supporter in the

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2 The term Murri is colloquially used in Queensland.
school community. As a result many children regularly ask for more tutoring sessions and often come to see their tutors if they are upset or having any problems. The tutoring session is a good place to ‘check in’ with the student and see how they are managing in class and in school generally. Also if a particular child is proving problematic in class there is the option of the teachers sometimes being able to ask tutors to take a child in order to settle them down. The school will often call upon the tutors in the literacy program to help with any issues the student may be having at school as each child in the primary school will have at some point been involved in the literacy program. One of the main aims of the literacy program is the development of a one on one relationship between tutor and student and this relationship is very important in the achievement of students within this program. Thus, a relationship is usually developed between tutor and child, with children benefiting from a kind of informal ‘pastoral care’ as well as from academic encouragement. The support and encouragement of the tutors can assist the students to learn more effectively and interact more appropriately in the school community. Frequently poor literacy skills are a significant factor for truancy and behaviour problems (Gray 2000). This is one of the things that Gray and Partington (2003) argue is essential for the students’ academic success and regular attendance, that is, the formation of social relationships with teachers and others at school.

As a result of this program, the children at the school have regularly outperformed other indigenous students in the Queensland Years 3, 5 and 7 tests, particularly in the reading and viewing component. In many cases, the children have not only achieved on par with the state averages but also exceeded them (Pine Rivers School Annual Report, 2006, 2007).

While we see the example of Pine Rivers as an excellent case study of success for Indigenous students and communities, we do not advocate Independent Indigenous schools as the solution or blueprint for the troubles that plague Indigenous Education. What this case study signifies is that:

Organisations that have emerged from within the Aboriginal community and which reflect Aboriginal aspirations and priorities are functioning better than other structures that are imposed by the government’ (House of Representatives, 1990, p. 45).

We see this type of school as one aspect, albeit an important one, of working towards greater Indigenous ownership and community voice in the management of their own educational outcomes.
Towards a Reform Program in Teaching Mathematics

In this final section, we move towards a model of reform teaching in complex classrooms where the goal is to enable Indigenous students to learn and perform well in school mathematics. While this discipline has been quite outside the realms of many of the life worlds of Indigenous people, what we have shown in the earlier sections of this paper is that 90% of Indigenous people live in urban settings so have exposure to numerate cultures. This is less likely to be the case for Indigenous people living in isolated and remote communities. The alienation from school that has also been noted in the earlier sections can be considered in terms of rational reaction to the symbolic violence enacted through school processes. Expectations held of learners are also critical to success. Further, the belief that mathematics is a linear model and where Indigenous students have absences from schooling that there are considerable gaps in their learning has been significantly challenged by the work of O’Toole and colleagues where mathematics learning should be seen as a network and where learners have many paths through the maze of mathematical concepts. These pathways will be influenced by many factors but as O’Toole has shown, the linear model is not appropriate for mapping student learning. Further, both-ways education models have acknowledged that there was significant possibility in providing curriculum that legitimated Western and Indigenous models of learning and knowledge (Watson & Chambers, 1989). In the extensive research from literacy education, it has been found that provision of quality pedagogy and appropriate scaffolding along with high expectations of learners has resulted in significant gains for Indigenous students (Gray, 1999). Currently many of the mathematics programs that have been implemented for learners of mathematics have been founded on deficit models – of learners and of the curriculum. They often rely on old models of learning that have been premised on models that have (unsuccessfully) been employed in schools. As Clements (1989) had argued, what most students learn from their exposure to school mathematics is that they can’t do it. This begs the question why such models still pervade but even more so, in the context of Indigenous education, why such models are transported into these contexts and expected to work? Collectively, these earlier iterations draw attention to the need for a model of reform that has high expectations of learning mathematics.

Boaler’s corpus of work on reform classrooms in the UK and US has shown that rich learning environments have enhanced the depth of mathematics learning for students from disadvantaged classrooms. Her comprehensive work undertaken in the US where classrooms used Complex Instruction (Cohen & Latan, 1997) documented the high success of mathematics classrooms in some of the most disadvantaged communities in California. Based on a wide range of research,
Complex Instruction has a number of features that enable a rich pedagogy, high levels of mathematics, high expectations of the teachers that the students can learn complex mathematics, and the need for quality learning experiences. This approach has strong synergies with the productive pedagogies approach (Lingard, 2006) that has been used in the Australian context.

In the remainder of this paper, we draw on these literatures, juxtapose them with the complexities of teaching in Indigenous classrooms, and underpin them with a Bourdieuan approach to propose a way forward. The approach that we advocate is one that is grounded in considerable research coming from the field of mathematics education and education more generally. It challenges much of current practice and moves towards an approach that draws on learning theories rather than the taken-for-granted practices of mathematics education as it is currently practiced in many classrooms. We also acknowledge at this point, that implementing reform is never easy, particularly in mathematics. Such resistance to change has been documented by many mathematics education researchers, particularly those whose work is in the area of equity (Gutierrez, 1998).

Leadership
In implementing reforms in classrooms, leadership is critical. As we have noted earlier, the leadership within Indigenous contexts may often be a devolved form where the role of leadership may be taken up by teachers as well as principals. Further, we also argue that the leadership is critical in terms of curriculum leadership. However, we also extend the notion of leadership to the students so that the pedagogy approach fosters leadership among the students.

Working as a Mathematician
We draw heavily on Burton’s (Burton, 2001, 2004) work with research mathematicians and how they go about their work. Her work posed serious challenges to the pedagogies found in so many classrooms. By showing how mathematicians work, Burton proposed that the pedagogical practices of contemporary classrooms needed to be changed. Her work showed that mathematicians valued highly collaborative work; that mathematicians have emotional, aesthetic and personal responses to mathematics; that intuition and ‘aha’ moments were common; and that mathematicians desired to seek and see rich connections between the various branches of mathematics and between mathematics and other disciplines. The emotional aspects of working as a mathematician have also been noted by Davis and Hersh (1998, p. 169) where they lamented that “blindness to the aesthetic element in mathematics is widespread and can account for the feeling that mathematics is dry as dust , as exciting as a telephone book ….”
Group Work
From Burton’s work and learning theories, the value of collaboration in learning is widely recognised and yet in most mathematics classroom the teaching of mathematics is an individual pursuit. With Indigenous students, we suggest the need for collaboration is even more important due to the strong sense of community among many Indigenous cultures. By enabling students to work in groups where each member is able to bring their own particular strengths and knowledges to the situation, there is greater opportunity for students to build on each others’ thinking and so come to a richer understanding than would be possible if working alone. Furthermore, when structured well, group work has been found to enable the inclusion of students who may have cognitive or social challenges (Lewis, Trushell, & Woods, 2005). However, the group work must be well structured so that it is not the case of students sitting in a group working individually. The tasks must be carefully chosen so that there are a range of skills needed for the resolution of the task.

Within this approach, the collective strengths within the group enable a group to complete a task that would be more difficult (if not impossible) by working alone. The group assumes responsibility for the learning of all members in the group so that if one student does not appear to understand the concept/s that are the focus of the lesson or activity, then they need to support their peer so as to enable him/her to understand the work.

There is a significant literature on group work and how best to organise the small groups. We recommend that the group work would have 3-5 children in each group. However, in many communities, the class sizes are small – in some cases, there may only be enough for 1 group in a class, and that the group may consist of family members due to the ways in which the community is formed. This creates a unique context for group work in some Indigenous communities, particularly those communities that are in remote areas of the country. However, while such constraints may create particular circumstances, the principles of group work outlined below can be adopted and would encourage interaction and deep learning – mathematically, socially and linguistically.

Roles defined
The early introduction of group work entails considerable background work to be undertaken so that students are able to make the most of collaborative learning. In part this is due to the widely held view that maths is an individual pursuit. From Cohen and Lotan’s (Cohen & Latan, 1997) work, roles within the group are defined. They argue that one of the key roles is that the group leader assumes responsibility for identifying when all members of the group seem to have developed the appropriate understandings that will be robust enough for teacher
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Within the group, the roles are to enable cognitive work to be undertaken. In some group work, roles are assigned (such as notetaker, gofer, etc) that enable the students to avoid participating in the cognitive work of the group and hence withdrawing from the intellectual activity. In this approach, the roles are to enable all students to participate in the group. The roles may vary depending on the activity but could include the following:

**Moderator:** This role has the group member ensuring that there is a balanced participation in the group and that all students have the possibility to engage in the activity. This role ensures that one student does not dominate the conversation or activity.

**Philosopher:** This role is to promote and provoke discussion through the use of questions. The questions can be used to foster deeper thinking about the issues; to justify a position being taken by a member of the group; to clarify responses or comments made by members of the group and so on. This is achieved through the use of questions.

**Scout:** This role is a more subtle one and is to encourage the participation of the more quiet students or of students who can be excluded by their peers. In Cohen’s work on Complex Instruction she focused on the importance of inclusion of socially marginalised students. This is one aspect of this role. Some students are often shy and reserved and may have significant things to offer but do not come forward easily or of their own volition. The scout listens and/or observes the group work and seeks to find subtle nuances in his/her peers and then encourages that person to offer comments. The role is different from the moderator (which is more about controlling dominant members). This role is about engaging the quieter members in the group.

**Teacher as Facilitator**

The teacher’s locus of control is substantially different in this approach. Rather than directing the lesson, the teacher must select or design activities that will enable students to work independently of the teacher. Appropriate scaffolds need to be developed in advance so that students are able to take control of their own learning. The teacher will work around the groups, taking particular notice of discussions so as to draw on these at the end of the lesson to demonstrate the diversity across the groups. When the students are in the groups, the teacher will set the students to task, and then, when called over by the group leader, select one student to respond to her/his questions. Where a student does not understand the questions being posed by the teacher, then the teacher walks away and the students assume responsibility to enable their peers to better understand the mathematics. This shifting of control from the teacher to the...
students is a significant move away from the usual ways of teaching in mathematics. In this model, the main role of the teacher is to design or select tasks that will engage the group in deep mathematical learning rather than in direct teaching.

Questioning

The role of questioning is a key aspect of this approach. It has been noted in other research, that the questions posed in mathematics classrooms are often low order, recall type questions. These result in a low level of intellectual quality that has been noted in mathematics classrooms through the QSLRS study. To shift to a higher level of thinking, the posing of questions that foster deeper knowledge and access deeper understandings requires a shift to higher levels of questions being posed. A simple taxonomy of questions (Biggs & Collis, 1982) can be used to develop questions to stimulate much richer conversations – either in the group work or at other phases of a lesson. Similarly, the work that has been undertaken through approaches such as the Philosophy in Schools approach also relies on higher order questioning. Students also need to learn how to pose questions to their peers. Scaffolding students to enable them to acquire this skill may take some input, particularly in Indigenous contexts where such a process may be more difficult due to cultural and linguistic barriers to this approach. As Boaler (2008) found in her work in the US, enabling students to engage in higher levels of questioning to their peers helps to facilitate higher levels of interactions and respect for their peers which has significant flow on effects. Questions that seek to have students justify, clarify, extend etc their thinking strongly aligns with the ways of working as a mathematician.

Rich Mathematical Tasks

Drawing heavily on the work from productive pedagogies where the intellectual quality of tasks is the focus of teaching, the selection or design of mathematical tasks becomes critical. Of primary importance is the richness and depth of the mathematics learning that is facilitated through the task. The task can vary in duration but it is a significant move away from the small lesson activity that dominates much contemporary practice. By creating learning opportunities that encourage depth of learning, it is recognised that learning takes time and cognitive energy so that the short activities that occupy significant curriculum time in mathematics (Education Queensland, 2001), there is little opportunity for depth of learning. Further, rote and skill/drill learning is very shallow learning and has little value in terms of the depth of learning that Burton advocated. Drawing on Burton’s (2004) work on research mathematicians, the task should allow for students to work mathematically. By creating opportunities for the ‘aha’ moments; for connections among mathematical ideas; to draw on early learnings (of the
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Creating opportunities and scope for students to express their mathematical thinking and reasoning in ways that suit the individual, the context, and/or the task allows for greater inclusion in activities. Learners may have preferences in terms of how they think through problems – creating mental maps; using logic and reasoning, drawing pictures, using mathematical notations and so on – so creating space in the curriculum to cater for these different ways of thinking, learning and representation opens up the learning opportunities for students. This is particularly the case when students are encouraged to share their ways of thinking with their peers. Such communications can happen within the small group work or at the end of the lesson. By sharing their representations with peers allows students to access other ways of thinking and representing mathematics so as to extend current modes of operating. Further it creates opportunities that enable students to create networks of thinking mathematically (Burton, 1999).

Use of Home Language

For many Indigenous students living in remote or regional areas, the speaking of English is a second language activity. Indeed, in some areas, English is spoken primarily at school with most communication outside the school being undertaken in a home language. Often this is a Kriol. In many urban settings, the students often speak a form of English that may resonate with much of everyday English but still be somewhat different from the middle-class English of formal schooling. These forms of English, often known as ‘Koori English’ or ‘Murri English’, have their own structures and nuances. The work undertaken by mathematics educators who focus on mathematical instruction being in a second language or other language (for example the work of Setati and Barwell) highlights the complexities of mathematical learning and code switching. Creating space for students to negotiate complex ideas with their peers in their home language enables the students to reduce the cognitive load created by translation of basic language and thus free up cognitive space for the mathematical learning. In her work with Railside, Boaler found that the school enabled students to negotiate mathematical meaning in their home language (in this case, Spanish) so that the students were able to debate, challenge, clarify, explain in a familiar language.
and in that process come to understand the mathematical concepts. Once depth of understanding is made possible, students are better able to then report back at the conclusion of the lesson.

Reporting Back

Frequently teachers use the final session of a lesson for the students to ‘show and tell’ but in a reform classroom, this session becomes an important aspect of the learning. Not only do students report back on their group work, but interactions between groups become a central aspect of the classroom dialogue. Students may need to be scaffolded in learning how to pose questions that will support their peers in their articulation of their thinking and working as mathematicians. At the conclusion of an activity, the group reports back to the whole class. Students in the classroom are expected to pose questions to the reporting group that will seek to clarify the processes used by the group as they came to understandings; justify the processes and/or knowledge that has been created; seek clarification about aspects that are unclear; scaffold their peers when it appears as though there may be an error or misunderstanding; and to support their peers to move towards deeper understandings about the work that has been undertaken. These questions not only help the reporting group to develop richer understandings and connections but also support the other members of the classroom to understand the work that they have done as well.

The teacher plays a critical role in this phase of the lesson or activity. As the facilitator, it is prudent that observations have been made of the groups in the working time so that groups can be targeted in this phase to elicit different responses or ways of working. This careful selection of groups, and the order of their presentations can be an important learning process for all students. It does not mean that those with simpler or incorrect responses will go first in this phase as this would become as prescriptive as current practice. What would be sought is a process that will help student to better understand the concepts and processes that are fore grounded in the activity.
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Summary

In this paper we have sought to identify the complexity of teaching mathematics in culturally and linguistically diverse contexts, such as Indigenous classrooms. We have drawn from an extensive review of literature to provide the contemporary context of education for Indigenous communities while recognising that there is no one Indigenous community. Like all cultural groups, there is considerable diversity within the Indigenous people of Australia. This is a salient point but a critical one. The life worlds for Indigenous people is what provides a unifying theme that separates them from non-Indigenous people. However, we recognise that many of the obstacles that Indigenous people face can be likened to other oppressed groups in Australian education – working-class families, remote communities, rural communities, linguistically diverse communities and those living in poverty. Many of these factors are compounding so that multiple disadvantage is not uncommon. Coming to develop a mathematics education that will redress some of the structural disadvantage that is now entrenched in much teaching of mathematics was a central aim of this paper. To this end, we have posed a model that draws on a wide range of literatures. The model has pedagogy at its core. The focus foregrounds learning (as opposed to teaching) as the key proposition for quality outcomes for Indigenous students. The model proposed represents a significant shift away from many of the approaches that are used in mathematics teaching, particularly for students who are most at risk of failing school mathematics.

In drawing on Bourdieu’s theoretical project, we propose a significant shift in the practices of mathematics education. This shift will require strong leadership if it is to be successful as it challenges the status quo. This leadership will be from principals through to classroom teachers. The practices of school mathematics will need to undergo considerable change if the challenge to improve learning for Indigenous students is to be achieved. By building upon the habitus that the students bring to the learning environment and then creating opportunities to engage with the knowledge and processes associated with school mathematics, Indigenous students should have greater opportunities to acquire the skills, knowledges and dispositions that are central to success in this discipline. This approach is substantially different from the practices that have been so dominant in the teaching of mathematics but have been less than successful for Indigenous students. As such, a radically different approach is needed if the current situation is to be changed.
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