Mathematics Curriculum Development in Indigenous Communities

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Abstract
Traditionally indigenous communities, who comprise small nations such as those of the Pacific or who are situated within a mainstream society, such as the Maori of New Zealand and the Australian Aborigines, have been taught versions of a mathematics curriculum which could be found in most Western societies. The backgrounds and experiences of the students from these communities are often not valued in these curriculums and it has been suggested that this may contribute to the failure of many in school mathematics. This paper describes part of a project in which an indigenous school community of parents and teachers develops a mathematics curriculum. In particular, the curriculum development model used in this project, which questions some of the underlying assumptions made within the current curriculum documents, will be examined.

1. Introduction

Gilmer (1998, p24) has stated that '[t]o a large extent educators do, in fact, determine who studies school mathematics and by extension who will have careers in mathematics and what the legitimate products of mathematics will be'. In order to succeed at school, students need to take on the world of the school (Phelan, Davidson, & Cao, 1991, p235) which is often determined by a particular group of people. This group which makes decisions about the mathematics taught in schools, includes education bureaucrats and politicians and is most often of middle-class males of European background (Volmink, 1994, p57). They define what is to be valued and the ways in which it is valued and this is institutionalised within school curriculums. Even in indigenous nations such as those in the Pacific, curriculums tend to be 'localised' versions of something which originated in a Western country (see Thaman, 1997 for a description of the situation in Pacific Island countries) and the originators could still be considered European males. Mathematical ideas from other cultures are dismissed as, at best, inferior practical mathematics (Joseph, 1997, p67). Discussion about changing the curriculum, to include the background of students, is often rejected as a lowering of standards (Thaman, 1997, p3). As well, beliefs about parents holding such views often hinder attempts at change (Murtadha-Watts & D'Ambrosio, 1997, p775).

Consequently, one group's knowledge can control other groups' abilities to change their circumstances. Students and their communities must accept the mathematics education provided in schools. Some students choose to distance themselves from their home community and culture and adapt to the school culture so they can succeed. If they reject the school culture in order to maintain their home cultural identity, the result can be withdrawal and the labelling of students and their communities as disadvantaged (Troyna, 1984, p78). The home community rarely benefits from having their children educated in school. If the children succeed at school, they no longer belong to that community and if they do not succeed then they have not learnt sufficiently about the mainstream culture in order to manipulate it to the advantage of that community.

Bakalevu (1998, p14), in discussing the lack of achievement by indigenous Fijians in mathematics, described how the culture of schooling was very different to the Fijian home culture. Harris (1989, p86) also emphasised how the differences between the home and school cultures were poorly understood by the non-Aboriginal teachers of Aboriginal students and this could contribute to students' poor results in mathematics. In the Northern Territory of Australia, the only mathematics course available to Aboriginal high school students, who choose to stay in their community to study, was at the lowest level. In New Zealand, in 1985 two thirds of Maori students left school without

any formal qualifications (Ohia, 1993 p106). These communities have not benefited from having Western-educated members in positions of power where the aims of their communities could be supported.

In order for students to succeed in school mathematics without losing their cultural identity, it seems necessary to involve community members such as parents in making decisions about the mathematics curriculum to be used in their school (see Lipka, 1994 for a description of a mathematics curriculum project with Yup'ik communities in Alaska). Parents and teachers could share their knowledge of the students, community aspirations and culture and the teaching of mathematics. By challenging them to think about how they were positioned by their own mathematics learning, options for their children could be raised. It is hoped that through this process, a mathematics curriculum could be developed which would be better understood and therefore supported by all stakeholders. The distance between the students' home community and the school could then be lessened.

2. Community-negotiated mathematics curriculum development

I have designed a model for mathematics curriculum development which is presently being trialled by an indigenous school community as they develop their own curriculum. As power relations are usually embedded within mathematics curriculums through an opaque process, it is important to make the model for curriculum development used in this project as transparent as possible. Outlined below, is a brief description of the school community and the mathematics curriculum development model. This is followed by some community members' comments about the curriculum development process.

2.1 The school community

The school is in a provincial town in New Zealand. It is a Kura Kaupapa Maori where instruction is in Maori, although not all parents speak Maori, and there is an emphasis on the maintenance of Maori culture. An expectation of Kura Kaupapa Maori is that parents participate in meetings about the running of the school. Mathematics, however, is the first curriculum area where parents have been asked for their input. The school is small, having three primary classes in the first year of the project with a fourth class, for high school students, added in the second year of the project. The teachers are also parents of children at the school.

2.2 Mathematics curriculum development as praxis

Traditionally a mathematics curriculum 'must include aims, content, methods and assessment procedures. Above all, the part played by the individual teacher must be recognised' (Howson, 1979, p134). Although these are important components of a mathematics curriculum, they do not consider the power relations which determine how some knowledge is regarded as being more valuable than other knowledge. So that the power structures could be challenged, I based the model for mathematics curriculum development upon the ideas of Freire (1996) and critical theorists from the Frankfurt School (Gibson, 1986) and others (Apple, 1979). They have been writing for almost thirty years on how individuals and communities who have been positioned by societal structures, like education, can modify their situations. These approaches have mostly been used in regard to the teaching of literacy to adults, (see Davidson (1998) for an overview of these programs), but some mathematics educators such as Gerdes (1985) and Frankenstein (1997) have used these ideas in their teaching of mathematics to adults. Although Lipka (1994 p27-28) mentions the work of Freire in regards to the negotiation of mathematics curriculum with Yup'ik communities, Freire's ideas

were not central principles on which the projects were based. However, there seems to be great advantages in using these ideas in curriculum development with parents and teachers of indigenous communities.

One of the important ideas of Freire (1996) and critical theorists was that of *praxis*. Praxis is a dynamic relationship between reflection and action. It involves oppressed people in developing understandings not just about their situation but also the underlying causes of it, thus allowing them to decide on action which could alter that situation. Reflection will influence action but action could then result in changes to the reflection. It has been incorporated as the central principle of this model of curriculum development. The use of praxis would involve parents and teachers examining some of the wider societal practices that affect their general situations as they developed the mathematics curriculum for their school. I have related the characteristics of praxis to those of mathematics curriculum development in order to determine the necessary elements of a model that could instigate changes in power relations. The table below outlines the elements of praxis which relate to mathematics curriculum development.

Praxis	Elements
Who?	• curriculum development should be done by a group. This group could include parents, teachers and other indigenous community members as well as representatives of the mainstream society. • all participants must be recognised as having knowledge which is worth contributing to the development of a mathematics curriculum. This information is shared to the group through dialogue. • outsiders, such as mathematicians, may have ideas which the groups could also consider. However the outsiders' knowledge and roles will be different to that of school community members.
What?	• the purposes of mathematics education in school need to be considered through dialogue on issues that are usually considered part of curriculum such as ends, teaching methodology, assessment.
How?	• curriculum development should involve simultaneous and continuous reflection and action. • curriculum development requires a questioning of the assumptions about the purposes of education in schools and the role of mathematics education within this. • different and contradictory aspects of the same issue should be presented for discussion and resolution by the group. The different consequences from different decisions on certain issues need to be considered. • curriculum development is part of a wider ethical investigation of society • there is an expectation that not only will the group develop a mathematics curriculum together but their understandings about education, mathematics and their own community will have been altered.

Table 1: The elements of praxis

2.3 The Framework

Based on these elements, I designed a stand-alone document, the Framework, which could support mathematics curriculum development in a variety of small indigenous communities. By trialling it with

one community I hope to uncover major problem areas and determine ways of making it as flexible as possible.

The Framework has two parts, the issues and the process, which are shown in Figure 1. The first part is about the process of developing a mathematics curriculum. Although school communities are encouraged to use a process with which they were
already familiar, a process of curriculum development is also described. It consists of discussion, research and consensus decision making and is based upon the elements of praxis for curriculum development in Table 1. Some general questions are included at the beginning of the Framework and could be used at any time during the curriculum development process. These are:

- How is the issue relevant to your community?
- How can the background of the students be reflected in the mathematics curriculum?
- How is the mathematics curriculum meeting the needs of the community?
- Is the mathematics curriculum culturally relevant?
- How easily can the curriculum be implemented in the classroom?
- How does this issue relate to the other issues you have looked at?
- Are there people inside or outside the community who could help with this issue?

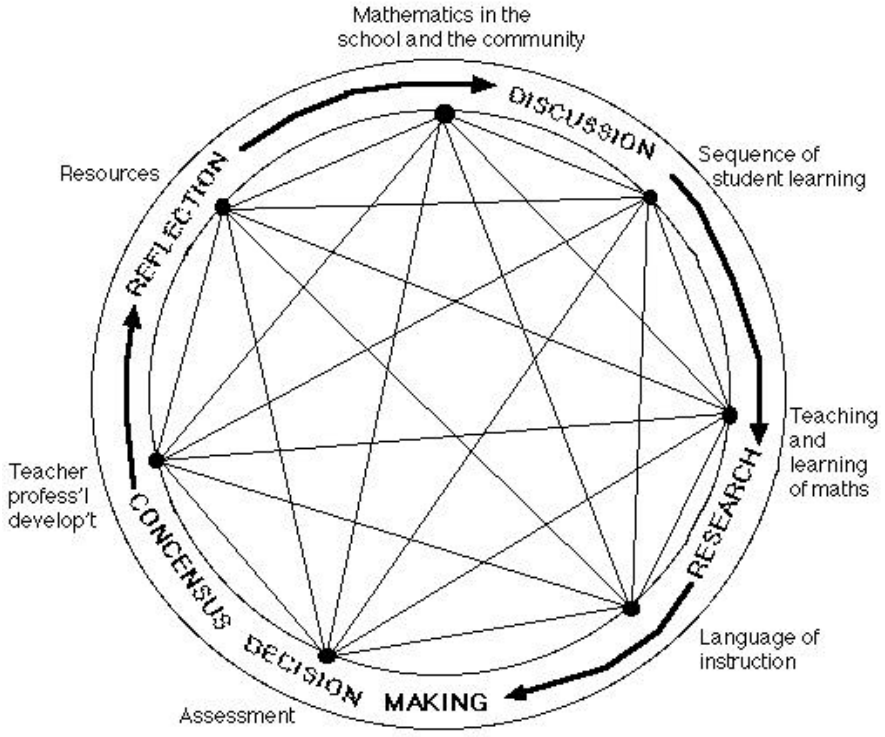

Figure 1. A diagram showing the interconnections between the issues, and their relationship to the process of mathematics curriculum development.

After the first three curriculum development meetings held by the school community, a further question was added which was:

- Are there any other documents that the community should consider with this issue?

The second part of the Framework is a set of issues with which the school community could interact, if they considered them relevant to the needs of their children and community. These issues are based on those which are generally considered to be part of a mathematics curriculum. The issues are:
(a) mathematics in the school and the community
(b) sequence of student learning
(c) teaching and learning of mathematics
(d) language of instruction
(e) assessment
(f) teacher professional development
(g) resources

The issues could be considered in any order. As one issue is discussed, the community could decide to make a connection to another issue further on in the Framework or to revisit an issue which had already been considered. A decision about one area of the mathematics curriculum could have implications for other areas of the curriculum. Some communities could decide that a particular issue is not relevant and may not consider it at all. Other issues could also be added.

The format for each issue is similar and consists of a questionnaire, background information, discussion questions, ideas for tackling the issue and references to relevant articles. The questionnaires could be used to focus on an issue before formal discussions begin or could be sent to community members who are unable to attend meetings but whose opinions should be sought. Different points of view are given in the background information. A series of discussion questions are also provided which highlight some of the contradictions in the issue. It is hoped that they would encourage critical reflection and discussion. These questions may also suggest research that community members may want to undertake to help them come to a decision about an issue. The suggested ways of tackling an issue make connections to videos, overheads or other resources which are contained in a separate resource folder. There are also suggestions on how activities such as concept maps and retrieval charts could be used to help organise ideas. Many of the articles mentioned in the reference list would also be in the resource folder. These articles are available so that community members, who wish, could read more extensively about different aspects of an issue.

3. School community thoughts about the process

As the Framework was designed to support school community efforts to develop a mathematics curriculum, it has been essential to monitor not just what happens during the process of curriculum development but also community members' views of the process. As a result, all curriculum development meetings are taped. Some documentation happens either during or after each meeting which is available at subsequent meetings. As noone attends every meeting, there are often people at a meeting who have missed the previous two or three. Interviews are held so that more information could be ascertained about areas of the Framework which seem to be problematic. They are conducted with both teachers and parents and were held before the process began as well as during the process. After problems have been discussed, interviews were also used to discuss possible changes to the Framework or process.

The next section records some of the comments made by community members during the curriculum development meetings, as well as comments about the process itself which came from the interviews. These comments provide insights into how the Framework was used and considered during the meetings and interviews and are left in community members' own words. Translations of the Maori words are given in brackets afterwards, as are references to any New Zealand documents mentioned. It is not possible in this paper to discuss the whole curriculum development model, so the comments have been organised around three of the elements of the model, which are:
• all participants must be recognised as having knowledge which is worth contributing to the development of a mathematics curriculum. This information is shared to the group through dialogue.
• the purposes of mathematics education in school need to be considered through dialogue on issues usually included with curriculums such as ends, teaching methodology, assessment.
• curriculum development should involve simultaneous and continuous reflection and action.

3.1 Valuing of parent and teacher knowledge

As was expected by the Framework, the parents and teachers had a wide range of views about mathematics education which came from a variety of different experiences. Parents contributed their own school experiences of learning mathematics:
'when I went to school, we had to memorise it, we had to sing it out to our parents'
'but it was as if you were in the dummies class'

As well, they made references to their children's experiences of learning mathematics:
'he learnt with calculators and he just cannot add or subtract'
'maths homework isn't actually a particularly pleasant experience for my kids'

Parents contributed from their work experiences: 'she was amazing, she could just do it in her head. But there were just certain things she couldn't do and she couldn't use the calculator'.

Parents also had other experiences such as knowledge of traditional activities and knowledge about their children: 'this is a perfect vehicle, `cause you can incorporate things out of their background and not only are you using mathematical concepts and applying them in a situation but you are also given a chance to revise and revitalise the practices of our tupuna [ancestors]'.
'It was something that I know and I've known from childhood, but to realise that you can connect it to a classroom exercise, it was just wow, it was neat, it was really neat'.

The teachers provided their knowledge about mathematics and the requirements of the Ministry of Education: 'mathematicians have developed terms and there are Maori terms for most of those and so when the time is right to apply them without taking away their [the children's] own mana [prestige] ... they will need to know the other term for later on when they are no longer here'.
'Education Review Office [office replacing that of School Inspectors] is asking "Can you show that you work from this level on the curriculum [NZ national mathematics curriculum]?" ... and I am not sure how legally binding that is'

In the interviews there were reactions to what people contributed, one teacher stated:
'I was pleasantly surprised by people's willingness to share their ideas about mathematics. I think a lot of people there were surprised at how much they could talk about mathematics.'

However he was also concerned that parents may not have enough background to make some of the decisions asked of them by the process: 'if you are going to make some huge decision about what will be the skills and content and understandings you will have of mathematics, you actually need to be taught or know the range of them.'

Parents themselves were not always sure about the contribution that they could make:
'we don't know what a curriculum is, we don't know what is expected, what children have to learn'.

Although there was certainly a recognition of what they could contribute: 'The parents have to be involved, not so much to participate but to involve themselves within the curriculum and because each parent knows the learning capability of their own child.'

Many parents were aware of how their lack of school mathematics had contributed to their own ability to obtain jobs and were very committed to having more options for their children. However there was an issue about whether parents were able to make appropriate curriculum decisions without knowing more about mathematics. Their experiences contained what they could see as options for their children. The sharing of experiences did mean that parents did have access to a great range of knowledge. On the other hand, there was not an equal recognition that the teachers needed to know more about the children that they taught. This could be because the teachers in this school were also parents but there was also an implicit valuing of teacher knowledge above that of parents. It is difficult to know how a stand-alone document such as the Framework could support parent knowledge more. Challenging questions and other examples will only provide support in situations where the whole community has already started to query how knowledge is valued. Neither parents nor teachers seemed to be querying this.

3.2.2 Purposes of mathematics education

For this school community, mathematics had three components, which represented the reasons why mathematics should be taught in school. They were Balance, Logical Thinking and Maths in the Real World. All of these were, however, seen as being affected by Attitudes and Feelings towards mathematics. If students did not like mathematics for whatever reason, they were not going to appreciate any of its parts and the purposes for teaching it would be lost. Attitudes and feelings coloured the mathematics of adults as well as students and some descriptions, of this influence, given by community members were: 'maths was just something I was frightened of'.
'I just liked doing it because you got the satisfaction about this problem and it had been frustrating till you got the answer'.

• Balance - There was a sense that mathematics was about putting things in sequence and that it used the ideas of symmetry so that everything was balanced. People said:
'if it is just rote, they've got to go through the rule'.
'the sun will tell me what time it is in the day'.

• Logical Thinking - Mathematics was seen as something which could help you think, by giving insights into the world: 'it's about teaching people to think laterally'.
'that's the process ... because you defined the method'.
'because I measured it in my head'.
'it keeps your brain functioning and that's something that's quite challenging'.

• Maths in the Real World
Maths was seen as something which came from interactions between people. It also was useful in solving problems. Some descriptions were: 'it's just problem solving'.
'and the mathematics where my tupuna [ancestors] were mathematicians'.

As a consequence of these ideas about mathematics, parents and teachers also recognised that there were implications for other aspects of the curriculum. Teaching and learning methodologies needed to include an expectation that students need to enjoy mathematics if they are to learn it. Contexts used in teaching mathematics also had to reflect children's past, present and future lives as Maori.

Using discussion and dialogue to talk about these ideas was interesting for parents:
'there are so many things you can talk about eh? To do with one issue.'
'I thought it was a really good discussion, basic philosophy. It was really interesting like whether we integrate the maths into what is already there, say cultural things and what the children are already doing or separate and have some things specifically labelled maths.'

One teacher did feel that the advantages of having the school community think about the mathematics education they want for their students could be wasted if the Ministry of Education started to insist that there was only one way of viewing mathematics education, and only one way that students could learn mathematics.
'I'm starting to worry about what their [the Ministry of Education's] expectations are and how tied we are to what the Ministry of Education and the Education Review Office are heading towards'

Any school which reviews its mathematics curriculum will need to consider what are the requirements from outside authorities and whether they would want to query them. However, many parents' knowledge of their children's mathematics learning is coloured by their own school experiences. Discussion about the changes in emphasis in mathematics education has helped parents better support their children's learning especially in regard to homework. This was one of the aims of parents for being involved in curriculum development. By developing shared understandings about what happens within the school, the whole community are better able to work together in regards to the children's mathematics learning.

3.2.3 Continuous reflection and action

The school community paid considerable attention to what they were being asked to think about and what their actions should be. In regard to their own individual roles, one parent said: 'Because we go "god, we hated maths at school" so we have to be mindful of what we say if we want our children to say maths is something really good and it can be fun'.
'I think that if we can get a lot more understanding of mathematics for ourselves we would break the barrier for our children'.

and as a school community: 'You actually need to develop a curriculum that is where your Maori children are at the heart, once you've decided what type of Maori child is at the heart. Is it the Maori child who is in an urban setting who doesn't know much about Maori culture or language or is it the child who is brought up in a Kura Kaupapa out in the forest? Once you've decided what the ideal is then you can develop a curriculum that is suitable for that child or type of child'.

'the question that I heard initially was where do we start, what do we want to end up with so and I'm thinking shall we get all really political and do the document and start from scratch stuff?'
'I thought we combine it, we read it, bring our ideas here and the whanau [school community] plays around with it, with regard to that one issue'.
'so one of the things which has to stay at the back of our mind is anything which we develop here we have to make sure that we are in a position which is not going to jeopardise our ability to operate as a school in a sense of licensing from government approval'.
'because the curriculum is ours, because we develop it, ... we want to work and make it happen ... and there again we educate the whole whanau [school community] and our tamariki [children]'.

and as a larger indigenous community: 'you highlight the point about indigenous people that to make those scones you used prior knowledge and that we seem to think that if it is not written down then it doesn't have mana [prestige]'.

The school community was also aware that there was a need for reflection and action. One parent explained her participation by saying that: 'I like hands-on education, I want to have a say in what the kids do and I want to help'.

Another parent in discussing doing a hands-on mathematics activity said: 'it made them drag things up and out to get them in a position mentally and probably physically, I'm not sure, but mentally to be able to put quality into this process'.

One teacher in discussing what form the mathematics curriculum should take stated that: 'a conversation or a discussion is not enough because otherwise the teachers don't have anything concrete in front of them to develop their programmes on and the parents don't have anything on which to set their expectations, so we need a discussion document'.

The Framework does seem to be contributing to community members' reflection and action in regard to the mathematics learning of their children and the development of a mathematics curriculum. However, the project is not yet at a stage where the action is having a significant impact on the reflection. As the process continues, it is hoped that this will occur.

4. Conclusion

This school community is keen to develop a mathematics curriculum for their students but are aware of outside influences such as the Ministry of Education which affect what they can and cannot do. It would seem that the three elements of praxis in curriculum development, outlined in the curriculum development model, are being supported to some extent through the Framework. However there is valuing of teacher knowledge over parent knowledge which will influence the development of the mathematics curriculum. The community has a consensus about what they see as being the components of mathematics. They also realise that there are some implications for their mathematics curriculum as a result of their perception of mathematics and that they will need to think about these as they work through the rest of the issues. Community members are aware of the relationship between their reflection on these issues and the action which needs to happen as a result of this reflection.

At this early stage in the curriculum development, the Framework seems to be providing appropriate support although there are some issues which are still to be resolved. An in depth study such as this

also means that the Framework is modified as an analysis is done on the views on the community members who are using it.

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