Ethnomathematical Ideas in the Curriculum[1]

Shehenaz Adam
The University of Auckland

A study was undertaken to investigate the implementation of an ethnomathematical unit in a mathematics classroom in the Maldives[2]. The research was conducted during the first four months of 2002 at two primary schools and involved teaching grade 5 students an ethnomathematical unit of work on measurement. The unit was designed in conjunction with the teachers. In this article ethnomathematical curriculum models are discussed and the approach used in the study is described. Data are presented indicating teachers' and students' reactions to using such a curriculum unit. The data showed that despite the very traditional education of the Maldives, the ethnomathematical approach was appreciated and understood by teachers and students.

Classrooms or learning environments cannot be isolated from the communities in which they are embedded. Classrooms are part of a community with defined cultural practices. When students come to school they bring with them values, norms, and concepts they have acquired as part of growing up. Some of these are mathematical (Bishop, 1994). However, the mathematical concepts of the school curriculum are presented in a way that may not be related to the students' cultural mathematics. It has been hypothesised that low attainment in mathematics, especially in Third World countries, could be due to lack of cultural consonance in the curriculum (Bakalevu, 1998; Ezewu, 1982). Moreover, there is research evidence that including cultural aspects in the curriculum will have long-term benefits for mathematics learners. That is, cultural aspects contribute to recognising mathematics as part of everyday life, enhancing the ability to make meaningful connections, and deepening the understanding of mathematics (Bishop, 1988; Boaler, 1993; Zaslavsky, 1991, 1996). The field of ethnomathematics presents some possibilities for educational initiatives that would meet this situation.

The trend towards ethnomathematical approaches to mathematics curriculum and pedagogy reflects a comprehensive development in mathematics education. Ethnomathematical approaches are intended to make *school* mathematics more relevant and meaningful to learners, and to promote the overall quality of education. However, by implementing ethnomathematical approaches are we sure that the teachers and learners *get* the idea of ethnomathematics and, as a result, enhance the learning of mathematics? How would we know? As a step towards answering these questions, a study was initiated in the Maldives where an ethno-

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1 An earlier version of some sections of this paper appears in the MERGA 26 Proceedings (Adam, 2003).
2 The Maldives is an island nation located in the Indian Ocean 275 miles Southwest of India, comprising about 1190 coral islands of which 200 are inhabited, and with a population of approximately 270,000.

mathematical unit was designed in conjunction with teachers, and then implemented in their classrooms.

In this article what is meant by an ethnomathematical curriculum and the ethnomathematical curriculum model used in this study are examined briefly, and then the method used for data collection is presented. Research findings with respect to teachers' and students' reactions to using an ethnomathematical unit are provided, and the extent to which the ethnomathematical ideas behind the curriculum were understood is discussed. Finally, the practical implications of the study are highlighted.

The Ethnomathematical Curriculum Model

The term ethnomathematics was coined by D'Ambrosio (1985) to describe the mathematical practices of identifiable cultural groups and may be regarded as the study of mathematical ideas found in any culture. Moreover, ethnomathematics can be described as a way in which people from a particular culture use common systems for dealing with quantitative, relational, and spatial aspects of their lives (Barton, 1996). As such, it provides insights into the social role of mathematics. Ethnomathematicians argue that the pervasive view of mathematics as Eurocentric and value-free misrepresents the evolution of modern mathematics through the ages. Some of these researchers plead for a more culturally sensitive view of mathematics to be incorporated into the school curriculum (Adam, 2002; D'Ambrosio, 1985; Zaslavsky, 1991).

From the literature on ethnomathematics, five different possibilities for an ethnomathematical curriculum can be identified. Many implemented programmes offer aspects of more than one of these. However, all characterisations are premised on the belief that an ethnomathematical curriculum is one in which the cultural aspects of the students' milieu are infused in the learning environment in a holistic manner. The infusion is manifest in the epistemology of mathematics, its content, the classroom culture, and the approach to mathematics learning (Adam, Alangui, & Barton, 2003).

One possibility for an ethnomathematical curriculum could be labelled as *mathematics in a meaningful context*. The New Zealand Mathematics Curriculum (Ministry of Education, 1992, p. 12), for example, states that:

> It is important that students are given explicit opportunities to relate their new learning to knowledge and skills they have learnt in the past. …
>
> …It is particularly important that mathematical learning experiences of Maori students acknowledge the background experiences, which have led to the formation of ideas and skills, which those students already have.

This vision, *mathematics in a meaningful context*, is epistemological in the sense that mathematics is presented as a cultural response to human needs. Every culture is assumed to have such mathematical responses and these responses are valid content for a mathematics classroom. A classroom using this type of ethnomathematical curriculum would be full of examples that draw on the students' own experiences, or on experiences that are common in the cultural environment of the students. These examples would be vehicles for communicating mathematical ideas, which themselves would be relatively unchanged. It has been hypothesised that a curriculum of this type would affect how students think about mathematics rather than how or what they learn (Bishop, 1988; Zaslavsky, 1991).

A second possibility presents ethnomathematics as particular cultural content that is distinct from the universal mathematical concepts taught at most schools. Such content would include mathematical practices and concepts that belong to a particular social or cultural group. For example, distinct or prevalent designs or decorative forms such as those exhibited in weaving might become part of the mathematics curriculum. This ethnomathematical content could make up any part of the curriculum, from a small section to a major proportion of the total. One aspect of this approach could be looking at the historical development of mathematics in different cultures. Another aspect could be integrating multicultural mathematics materials into the regular instructional programme and using personalised activities that are related to different cultures. It has been presumed that a curriculum of this type will have benefits for student learning for motivational reasons (Zaslavsky, 1991).

A third conception of an ethnomathematical curriculum could be built on the idea that ethnomathematics is a stage in the development of mathematical thinking that a child goes through in his/her mathematics education. The ethnomathematical curriculum is that early part of the curriculum that focuses on the mathematical world of the child's culture (Begg, 2001). This vision of an ethnomathematical curriculum is psychological in that mathematical thinking develops concretely in practical situations, and "in order to succeed in studying a mathematical concept as an object, the subject must already have access to the concept as a tool" (Nunes, 1992, p. 571). A justification for this curriculum is that mathematics should start with where the students are (Begg, 2001), then make connections with mathematics in their culture, and then link it to world mathematics. A curriculum of this kind may benefit student learning in terms of students being aware of the mathematics found in their own culture and seeing mathematics as a living and growing discipline (Barton, 1996; Zaslavsky, 1991).

A fourth possibility of an ethnomathematical curriculum could be the mathematical part of the idea that all classrooms are situated in a cultural context involving cultural values, beliefs, and culturally specific learning theories. The component of this cultural view of the classroom that is specific to mathematics could include, for example, whether learning mathematics is predominantly oral or written, what a mathematics classroom looks like, what sort of mathematical authority is required in a teacher, and what should be the format of assessment. If this way of thinking about an ethnomathematics curriculum is adopted, then it has to be decided whether a culturally specific classroom is a good thing and whether or not and how students during their education will experience other norms and values. This type of an approach to curriculum is suggested by Bishop's (1988) work on mathematical enculturation. In terms of learning, this curriculum will presumably help students because they will be in an environment that is more consonant with their cultural norms.

The final approach, and the one with which this study is aligned, sees an ethnomathematical curriculum as an integration of the mathematical concepts and practices originating in the learner's culture with those of conventional, formal academic mathematics. In this approach, the ethnomathematical curriculum takes the learner's world or culture and uses it explicitly to integrate these outside experiences into the world of conventional mathematics. In such a classroom environment, the learners will be building on what they know or on the experiences they have from their environment or culture. These experiences are then used neither as motivation, nor as an introduction, but as part of understanding how mathematical ideas develop, how they are built into systems, how they are formulated, and how they are then applied in various ways within the culture. This mathematical knowledge is related to conventional mathematics in such a way that the underlying mathematical ideas are fully understood, and the power and utility of conventional methods are appreciated. Links are made to familiar practices and concepts by realising and understanding the need for mathematical characteristics such as accuracy and formal reasoning in both mathematics and in real-life situations. The understanding of conventional mathematics then feeds back and contributes to a broader understanding of culturally-based mathematical principles. The work of Lipka (1994, 2002) in Alaska is an example of this type of approach to curriculum innovation. It is assumed that a curriculum of this nature will motivate students to recognise mathematics as part of their everyday life, enhance students' ability to make meaningful mathematical connections and deepen their understanding of all forms of mathematics (Adam, 2002; Barton, 1996; Boaler, 1993).

Therefore, before designing and implementing an ethnomathematical curriculum, there are several questions that need to be addressed. For example, what are the reasons for adopting this kind of curriculum? How are decisions made about which cultural mathematical ideas to include in the curriculum? Why are some cultural ideas valued and not others? Do the learners who share the same indigenous cultural environment have the same experiences and mathematical knowledge? Is it possible for a teacher who has been schooled in conventional mathematics to identify mathematical ideas that do not resemble conventional mathematics? Does an ethnomathematical approach imply a specific teaching style? What are the links between an ethnomathematical approach and the indigenous language?

What are the effects of such an approach on the quality of the conventional mathematics being learned? (Adam, 2002; Vithal & Skovmose, 1997).

The framework for the ethnomathematical curriculum model (see Figure 1) used in this study is an adaptation of the ideas of Lipka (1994). The objective of developing an ethnomathematical curriculum model for Maldivian classrooms is to assist students to become aware of how people mathematise or think mathematically in their culture, to use this awareness to learn about formal mathematics, and to increase their ability to mathematise in any context in the future. Hence, the *bridge* in this model is the process of mathematising or thinking mathematically.

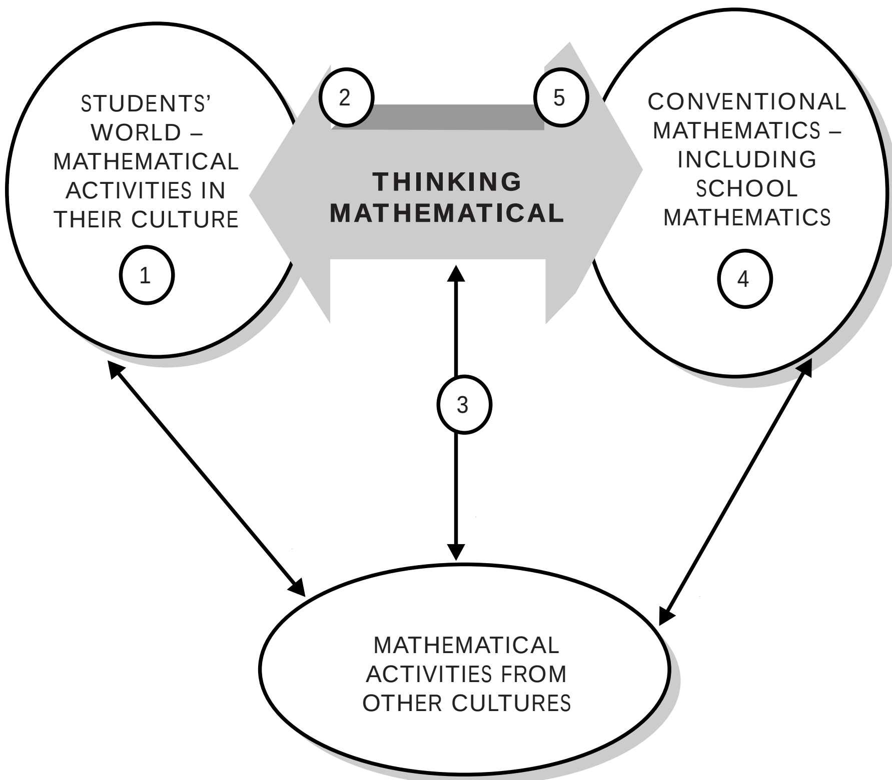

Figure 1. Framework for an ethnomathematical curriculum unit.

The model provides linkages between areas of mathematical activity. The connection indicated by the highlighted arrow that links mathematical activities in the students' culture to conventional or school mathematics is privileged by an ethnomathematical curriculum. A detailed version of this connection is given in Figure 2.

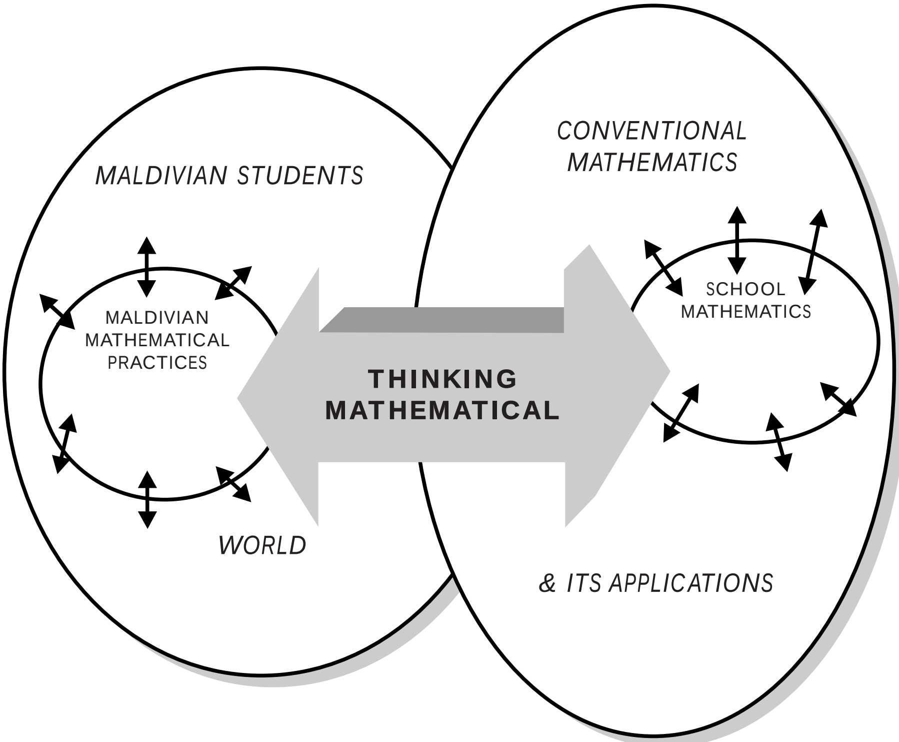

Figure 2. The connection, that links mathematical activities in the students' culture to conventional mathematics, privileged by an ethnomathematical curriculum.

In Figure 2, the arrows between Maldivian students' world and Maldivian mathematical practices characterise the relationship between the practice and the context and vice versa. Similarly, the arrows between school mathematics and conventional mathematics and its applications characterise the relationship between the practice (at school) and the context (conventional mathematics) and vice versa.

This ethnomathematical model leads to the development of a sequence of instructional activities (see Figure 1) that enables students:

1. to become aware of potentially mathematical practices in their culture so that they understand the nature and origins of mathematics better, as well as value and appreciate the existing knowledge.
2. to understand and experience these cultural activities from a mathematical point of view, thereby facilitating them to make the link between school mathematics and the real world or life in the Maldivian society.

3. to connect knowledge of their mathematics to parallel ones outside their experiences or culture using mathematical thinking, thereby facilitating them to appreciate that each culture has its own way of mathematising and that different strategies can be, and were, invented as needed.
4. to learn about and learn to use conventional mathematical systems, notations, and techniques by discussing the ways in which this mathematics was also developed in response to human needs.
5. to understand conventional mathematics better so that it feeds back into and contributes to a broader understanding of culturally-based mathematical principles.

The study described in this article proceeded using this model. There are several questions that arise from this way of thinking about an ethnomathematical curriculum.

The first concerns the way that understanding the nature of mathematics occurs as students become aware of the mathematics in their culture. In becoming aware, students see mathematics as a human activity rather than just a set of symbols, numbers, and figures which are presented only at school. They see a human face to mathematics. As a result, do they start asking deeper questions about mathematics and see mathematics as something one does to solve problems, communicate ideas, and reason out situations as part of their everyday life? What can teachers do to facilitate this?

A second question is: what do we mean by *thinking mathematically* if it is to be conceived as a bridge? Cultural mathematical practices can be related to conventional mathematical systems, and vice versa, through mathematical thinking. Mathematical thinking involves symbolising, generalising, abstracting, and making logical connections. This could be facilitated by seeing mathematics in various cultural contexts and learning mathematics through practical examples and investigations. However, as a result of relating mathematics to real world activities, do students' understandings of mathematical concepts, and the quality of the conventional mathematics learned, improve? And what can teachers do to make this process easier?

Third, what other bridges between cultural practices and mathematics are possible and appropriate? One possible bridge could be how the connections between mathematics and the real world are realised by both the teachers and students, that is, the examples they use, and the aspects of each that they choose. Another possible bridge is that the real world is just an example of mathematics but not a generator of it and, as a result, students' interest and motivation in learning mathematics may be enhanced. However, do mathematics teachers and learners make the link between ethnomathematics and mathematics? Even if they do, what is the extent to which this link is made? How would we know?

These questions require reflection upon the ethnomathematical curriculum model throughout the implementation process. The appropriateness of the model in the Maldivian classrooms was part of the analysis undertaken in this study.

To summarise, there are two intended outcomes for the ethnomathematical curriculum model. The first is that it brings a broader understanding about mathematics into the classroom mathematics programme. Most classroom mathematics curricula focus on mastery of skills, accumulation of facts, rules, and algorithms that are necessary for examinations. The curriculum is experienced as mathematical content (Begg, 1994), so most students leave school thinking that mathematics is something to be done only at school and that it has no relevance to their real lives. An ethnomathematical curriculum introduces an understanding about mathematics as part of mathematics education. When students understand the nature of mathematics, they will better comprehend the relevance of mathematics in the various aspects of their everyday life.

The second intended outcome is that the ethnomathematical curriculum focuses on mathematics as a process, rather than a collection of facts. The model is based on the idea that mathematics is a human creation that emerges as people attempt to understand their world. Therefore, mathematics is seen as a process, and as a human activity, rather than just as content (e.g., Ministry of Education, 1992). This implies that an ethnomathematical curriculum is not just about the application of relevant contexts in learning and teaching mathematics, but is also about generating formal mathematics from cultural ideas. Thus formal mathematics is better understood, appreciated, and made more meaningful to its learners.

In addition to these theoretical pedagogical justifications, there is a particular rationale for developing an ethnomathematical curriculum model for the Maldives. This country has a rich heritage of mathematics because of its close connections with the traditions of both Arabs and Indians. Mathematics has persisted through many generations and has been well adapted to Maldivian society. However, in recent years, the dependence on British examinations and the consequent reliance on the Western mathematics tradition have almost displaced indigenous mathematics skills. An ethnomathematical curriculum may revalidate these skills.

Another purpose for such a curriculum is to preserve the mathematical heritage of the Maldives. The march of globalisation, with its imperative for a single language and culture for communication, is decimating the linguistic and cultural pluralism of the world (Barton, 1996; Bockarie, 1993; McConaghy, 2000). A culturally based education may preserve the mathematical culture of the Maldives. Furthermore, Maldivian Ministry of Education statistics show that the pass rate of students in mathematics in public examinations has been relatively low. Research carried out in developing countries has shown that a culturally rooted pedagogy can be meaningful to mathematics learners (Bakalevu, 1998; D'Ambrosio, 1985, 2002). A study such as the one described in this article can further the debate about how to achieve better learning. Similar rationales may apply for any homogeneous Third World society.

The Study

The aim of the study was to investigate the implementation of an ethnomathematical curriculum in a primary classroom in the Maldives. However, the practical intervention was moderated by what was practically possible, so a small sample of one unit of work was used to illustrate for teachers and students what an ethnomathematical curriculum would be like. The study was designed with an ethnographic orientation, as it was necessary for the researcher to be actively involved in the research and the data were collected from the participants' points of view: their beliefs, ideas, behaviours, values, and assumptions.

The research was conducted at two primary schools and involved grade 5 teachers and students using an ethnomathematical unit of work on measurement (area, perimeter, volume). One school was in the capital, Male', where the language of instruction is English, and the other was on a rural island where the language of instruction is *Dhivehi*. Seven teachers and about 210 students in the Male' School were involved, and two teachers and about 60 students in the Island School.

Workshops were conducted with teachers before the implementation of the unit to induct them into the idea of the ethnomathematical unit and to work with them on draft materials. The unit planned and written at these workshops was then taught over three weeks replacing the standard unit in the curriculum. The three-week unit included the following:

- exploration, within the Maldivian culture, of some activities that have mathematical aspects. This exploration included students visiting a carpentry site, a construction site, a boat building shed, and the market, to observe and to gather information by asking questions and by experiencing these activities. The purpose was to understand the nature and origins of mathematics better, and to value and appreciate the existing mathematical and cultural knowledge.
- participation in activities relating to perimeter, area, and volume, using objects familiar to students. This participation included doing activities in the classroom using cultural objects. Vases, mats, seeds, coconut shells, and sea-shells, for example, were used in activities related to measurement. The purpose was for students to understand and experience the cultural activities from a mathematical point of view, thereby enabling them to make the connection between the real world and school mathematics.
- participation in activities related to perimeter, area, and volume, that were outside students' experiences or culture. This included, for example, measuring different objects using body parts and standard units. The purpose was for students to connect the cultural

mathematics to parallel ideas outside their culture. This enabled them to appreciate that each culture has its own way of mathematising, and that different strategies can be, and have been, invented whenever needed, and that standard measurements enable communication among cultures in a globalised world.

- participation in activities to learn about and to learn to use conventional mathematical systems, notations, and techniques. This included discussing the need for accuracy and examining real world instances where mathematical accuracy and formulae are needed, for example, a doctor's prescription. The purpose was for students to understand the link between the real world and conventional school mathematics, thereby facilitating their understanding of mathematical concepts.

During the data collection, information was sought from teacher workshops, questionnaires, classroom observations, interviews, teacher resources, and a research journal. A questionnaire was given to all teachers before and after the implementation of the unit, and interviews were conducted with all teachers after the implementation of the unit. Interviews were held with two students of each class in the Male' School and a questionnaire was given to all students at the Island School, after the implementation of the unit. All the interviews and questionnaires included open-ended questions. The teacher interviews and questionnaire included questions about how teachers felt about the implementation of the unit—the advantages and disadvantages, the impact on their teaching practice, what students gained from the implementation process, and their feelings about using cultural practices in the mathematics classroom. The student interviews and questionnaire included questions about whether students had noticed anything different in the way the ethnomathematical unit was taught, whether they recognised mathematics in the real world, and whether they made any links between mathematics in the real world and school mathematics and vice versa.

During the implementation of the unit, some classes were observed throughout. Some of the parameters used for observation were: the use of context during the lesson; the teacher helping and encouraging students to talk about mathematics in the classroom; the teachers' and students' use of their own ethnomathematical experiences; and the teacher and students linking ethnomathematics to school mathematics. The researcher participated as a colleague with the teachers involved and did not stand in a formal role with the students except by association with the teacher. On most days during the implementation, informal discussions were held with the teachers. This process of collaboration was insightful for the researcher, who was trained in the Western way as a secondary mathematics teacher doing research at primary level, and for the primary teachers trained in the Maldives as they came to understand the concept of an ethnomathematical curriculum.

All the data from questionnaires, interviews, journals, and other resources were analysed using the data handling tool, NUD*IST (QSR, 2002).

Evidence

With reference to some fundamental themes that emerged from the qualitative analysis of the data, the evidence from the teachers and students about implementing an ethnomathematical curriculum unit are examined in the following discussion. Some themes that emerged from the data included: teaching style, motivation and interest, awareness of mathematics in the society, and facilitation of the understanding of mathematical concepts.

Teaching Style

In the Maldives, examinations shape what is taught in schools. There is a tendency to focus on preparation for assessments and examinations, which usually leads to an emphasis on covering content material found in the syllabus. Teachers opt for providing students with the necessary skills by working out problems similar to those that are in the textbooks and that are likely to appear in the assessments. The mode of pedagogy in Maldivian classrooms relies heavily on the *transmission of knowledge* model (e.g., Begg, 1994). The use of the *chalk-and-talk* method is very common, and there is little inclination to experiment with either mathematical ideas or pedagogical techniques such as cooperative learning environments where students are encouraged to use problem solving, reasoning, and communicating skills. Similarly, it is also not normal for Maldivian teachers to engage in mathematical explorations. Apart from my own experience of Maldivian classrooms, the teacher interviews provided confirming evidence that teachers were aware of these shortcomings in their pedagogical practices.

> T7[3]: Even though I did learn different methods of teaching when we did teacher training, once at school, it all changed back to the traditional ways.

> T8: When I started my teaching career I tried to teach in such a way that students would be more involved in learning. For example, by doing group activities. But after a while, due to time constraints and no one being there to guide and give ideas, my teaching also shifted to more blackboard teaching.

The ethnomathematical curriculum model required that the learning of mathematics should involve experiencing cultural practices as they occur, and exploring these practices in a controlled classroom environment (e.g., D'Ambrosio, 2001). Thus, the implementation of the unit required a change in teaching style and in classroom discourse. Using cultural practices to exemplify mathematical ideas requires discussion, questioning, group work, and the use of students' knowledge. When cultural practices are used in the

[3] The nine teachers involved in the study were coded according to the school and in alphabetical order and given a number from 1-9.

classroom, it is likely that some students (or more likely their parents) will have more knowledge about the object of classroom study than the teacher, especially teachers who do not share the same social and cultural background as their students. As one non-Maldivian teacher acknowledged:

> T4: Especially because I am an expatriate teacher I am not used to these cultural practices even though I have heard about these things.

On the same note, the ethnomathematical approach provided opportunities for closer community and school relations. This was evident from the willingness of the people involved in cultural practices to share their experiences and ideas. However, a danger of community involvement may be that tensions could emerge due to the uncertainty of their role, as found by Meaney (2001) as she traced attempts to involve community members formally into the detail of curriculum policy and planning.

Furthermore, scholars in ethnomathematics argue for the importance of mathematical explorations and group work or communication in the mathematics classroom (e.g., Gerdes, 1994). This is because students need the opportunity to experiment and reason out mathematical problems, and need to be encouraged to talk about mathematics and share their ideas in a group. This is aimed at students having an understanding of mathematics and a better grasp of the relevance of mathematics to different aspects of their life.

Teachers did show some conditional willingness for mathematical explorations and group work. This was apparent from the responses that they gave when asked what their response would be if students were to protest after a group project that they would work better individually.

> T6: I will encourage them to work in groups explaining that more students together get more ideas.
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> T8: When you work in groups the weaker students can learn from the brighter ones. Also the brighter students can remember the concepts well when they explain it to someone.

During the implementation of the unit, the teachers did adopt exploratory and group work approaches. Teachers did not express problems with this approach except in one instance.

> T9: The class was quite noisy today. … If I conduct a lesson like this again, I will give different objects to different groups at different corners of the class. This way all students won’t gather around the same object and the lesson would be more successful than today.

In fact, teachers observed that students responded well to new teaching modes, and that this did not deteriorate into indiscipline.

> T8: Students were very much involved in learning when taught this way. … I also found that students didn’t have time to idle so we didn’t have any discipline problems also … they were so motivated and interested. …after we started doing the text book problems most of the students completed the exercises in advance.

T6: They [students] found the lessons very interesting as the lessons were very practical and they had a chance to do the investigations themselves. They really liked it.

Moreover, after the implementation of the unit, teachers expressed the view that they would try to teach other mathematics topics the way the ethnomathematical unit was taught.

T1: I will try to teach other mathematics topics this way. … I feel that when mathematics is taught this way, it is very beneficial to students. … they were very much interested and involved in doing the activities.

From the teachers' comments it can be concluded that one reason for teachers' willingness to consider the teaching styles required by an ethnomathematical approach was the students' being more motivated and more interested in learning mathematics. The change in students' motivation can be linked to the importance of giving students opportunities for mathematical explorations and communication by relating to the real-world for meaningful mathematics learning, as expressed by, for example, Gerdes (1994) and Zaslavsky (1991).

Thus, the style of teaching required by an ethnomathematical approach did not seem to be a problem. This acceptance could be because teachers saw it as a one-off temporary thing they could handle, or because the teachers did not realise the extent of the change being suggested. Nevertheless, there is sufficient evidence to conclude that the teachers were willing to contemplate the teaching styles necessary, were capable of implementing them, and remained favourably disposed to these styles.

Motivation and Interest

All teachers appreciated the motivational aspect of the model. They felt that once the measurement topic started, students were more involved, motivated, and interested in learning mathematics, as the unit allowed students to go out on field trips, ask questions, and do the mathematical investigations. Moreover, from the survey in which students were asked which method of mathematics learning they preferred, 91% of the students said that they preferred to learn mathematics the way they learnt the ethnomathematical unit on measurement. Typical of teachers' (T) and students' (S) comments were:

T9: The implementation was very effective. Students' interest in mathematics changed a lot and they were very motivated to study. I would also like to note that it was a great encouragement for the weaker students.

T7: I could see that students' interest in mathematics changed a lot during the time when the measurement topic was taught … previously they would look so bored and sleepy in the class. But once the measurement topic started they seemed to have lots of energy and I found that even in other classes they were much more motivated than before.

S11[4]: I prefer to learn mathematics this way … this way it is easier for me to understand and it is more interesting and fun.

S4: I prefer to go to field trips and then learn mathematics. Because when we learn in class we might not know some of the things. But when we go on field trips we know the things we have to learn in class and more than those things. So field trips are much better.

The students' enjoyment indicated above may not be due only to the implementation of the ethnomathematical unit of work. It may well be that Maldivian students who are used to the traditional method of *chalk-and-talk* teaching were relieved from the boredom of sitting in class, as they were able to go out on field trips, and experiment and explore some of the mathematical activities in the class.

Further evidence of the teachers' positive response to the unit was seen in their interest and willingness to come to workshops a year later, when the opportunity arose.

Nevertheless, it is not known whether the teachers and students would be interested and motivated if the same approach was followed in teaching and learning all mathematical units, or whether teachers' and students' positive feelings would be long lasting, and if they would persist if the whole curriculum or large parts of it were changed.

The motivational aspect was quite prominent in the data, and there is ample empirical evidence that good motivation is necessary for meaningful mathematics learning (e.g., Zaslavsky, 1991). The motivational aspect was not included explicitly in the ethnomathematical curriculum model framework for this study, thus there was a need to redraw the model to include this component.

Awareness of Mathematics in Society

Most of the teachers and some students volunteered the information that they had not previously been aware that mathematics existed outside school and in their culture.

S1: Before the measurement topic was taught, I did not think of mathematics outside school. Now I see mathematics everywhere. On the street … Mum also uses measurement in cooking—to measure the rice. At the fish market to sell the fish.

T2: It was easier for them [students] to understand that mathematics is something which is done everywhere, not only at school … this was something I also haven't thought of before.

The raising of awareness of mathematics in activities outside school prompted the realisation for some teachers that their traditional method of

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4 Students were coded according to the school and alphabetical order and given a number from 1- 270.

teaching had led to students thinking that school mathematics was not useful in the outside world.

> T8: I will include activities related to culture when teaching mathematics. When taught the way we have been teaching, students don't know how to use mathematics they learn at school when doing real life activities. They can't make the connection.

> T9: I will try to include activities related to culture when teaching mathematics, so that students would be able to see the link between mathematics and real life … also they [students] will realise the importance of studying mathematics.

The field trips and making connections between school mathematics and real world activities in the classroom during their investigations on perimeter, area, and volume were appreciated by students, and integrated into their view of mathematics.

> S4: People use area and perimeter when building houses and tiling the floor. Volume is used when dad builds water tanks … when we grow up we have to know how to measure, so it is important to learn these things … without mathematics we cannot do anything in life.

The students' realisation that they would be using mathematics outside school led to the unexpected finding that they, as well as the teachers, seemed to be viewing mathematics as a human activity.

> S10: I see mathematics outside school especially the mathematics in the activities that people do.

> T2: When students go out and experience different activities for themselves and ask questions … they also learnt about how people use mathematics in doing different activities in the society.

> S12: … before I never thought about other people using mathematics in their work.

From an ethnomathematical perspective, mathematics is a human creation that emerges as people attempt to understand their world (Adam, Alangui, & Barton, 2003). Therefore, this *active* view of mathematics is an important criterion for the success of an ethnomathematical curriculum.

The experience of the implementation of one mathematics unit provided evidence that not only the content of the unit, but also the wider aims of an ethnomathematical curriculum can be approached by teachers and students. On one hand, this success could be because the ethnomathematical unit was something different and it was stimulating for both the teachers and students. On the other hand, it could be because teachers were using original ideas and they were not narrowly focussed on particular aspects of the curriculum unit. This raises the question of how extensively this approach can be used through the syllabus, and how much is needed to achieve the wider aims of the curriculum. The ethnomathematical approach requires teachers to know more about mathematics and to have additional pedagogical skills in order to effectively help students. This is a complex process and it would take time to establish appropriate professional development. Another issue is that of encouraging teachers to engage in mathematical explorations so that they would be comfortable to use these strategies in their classrooms. As Maldivian teachers are not used to mathematical explorations they would need guidance and support. However, as such resources and expertise are limited, it may not be viable to use this approach extensively in the syllabus.

Facilitation of Understanding of Mathematical Concepts

Not only did this ethnomathematical approach allow students to make the connections between school mathematics and real world activities, but also seemed to assist their understanding of formal conventional mathematics, as is evident from both the teachers' and students' comments:

> T7: Previously when taught using chalk and talk, students were not very involved in learning mathematics. But this time … they had a better understanding and they were able to apply what they've learnt and it was easier for them to grasp the mathematical concepts. By the time we introduced the formulae, the students had an understanding of the concepts of area, volume and perimeter.
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> T2: This [approach] helped students' thinking processes and it was easier for them to understand the mathematical applications.
>
> S12: I can understand mathematics better now … I know how to use formulae and things better after seeing how people do things in [for example] construction of houses.

Even though assessment of formal mathematics was not associated with the research project, at the end of the ethnomathematical unit of work, a test on measurement, similar to previous years, was given both at the Male' School and the Island School. Male' teachers reported that the students performed well in the test and that they perceived that students had done much better in comparison to other mathematics assessments that they had done. Similarly, the Island School teachers observed that student performance was good and that the weaker students performed exceptionally well in comparison to their previous results. They felt that the reasons for this were that the students were motivated and interested in learning. This also confirms Lipka's (2002) findings that students who have been taught using an ethnomathematical approach perform better on conventional mathematics tests.

There are indications, therefore, that the ethnomathematical unit of work facilitated students' understanding of mathematical concepts through practical examples using cultural objects, investigations, and by relating school mathematics to real world activities. These indications of successes may well be due to the Hawthorne effect (Mayo, 1933) as the approach was something new for both teachers and students. Alternatively, it may be that teachers and students reported what they thought were appropriate responses to the study. Nonetheless, teachers and students also expressed what they thought were some of the difficulties of an ethnomathematical approach to mathematics. Further research is needed to find out more about the causes for change in teachers' and students' feelings and attitudes towards an ethnomathematical approach.

Practical Implications

The findings of this study in the Maldives highlight several practical implications for both mathematics educators and policy makers regarding the implementation of an ethnomathematical curriculum unit.

Even though Maldivian teachers are willing to try out new ideas, they need guidance in both designing an ethnomathematical unit of work and putting it into practice, as ethnomathematics is a new concept for them. Teachers need ongoing support and guidance. For example, at the beginning of 2003, a further workshop was conducted for teachers on another of the units of the grade 5 syllabus – geometry. At the workshop, teachers were enthusiastic and were willing to do more professional development activities; however, the confidence to initiate further work on their own seemed to be a problem. Researchers and curriculum developers need to be committed over a long time period.

As researchers, when we try out new things we need to tell students what we are doing and why, and involve them in curricular change. The students in this study seemed to appreciate and understand the benefits of this study. They were both interested and involved. This involvement in mathematical activities enabled them to be more interested in studying mathematics and they were able to relate real-world activities to formal mathematics—something they did not seem to be aware of before. However, the important question to be considered is how to move beyond motivation and application of mathematical ideas. More effort is needed to do this properly.

Practical issues such as length of time to complete the unit did not seem to be an issue academically. However, Maldivian parents expect visible *formal work* from their children. This expectation needs to be recognised in future curriculum developments so parents are comfortable with the new initiatives.

Conclusion

For many years now, education in the Maldives has relied on external ideas and resources. The current mode of pedagogy in Maldivian classrooms relies heavily on the *transmission of knowledge* model. However, the study indicated that there is great potential to develop an ethnomathematical curriculum model in the Maldives so that mathematics will be more meaningful to the students. Moreover, for the Maldives in particular, an ethnomathematical curriculum model will normalise mathematics education. This potential was recognised and welcomed by teachers, school administrators, and the community.

Thus, it is concluded that in a homogeneous context like the Maldives, and with the support demonstrated by the schools and the community, the development of the ethnomathematical curriculum can be continued more broadly.

There are many different approaches to an ethnomathematical curriculum, and which approach to use depends upon what one is trying to achieve. The approach in this Maldivian study was to use ethnomathematics as an educational tool to help students understand what mathematics is about, and to help them make it part of their own knowledge.

Despite the very traditional education of the Maldives, the reactions of teachers and students indicated that the ethnomathematical approach was welcomed, appreciated, and understood by both the teachers and students. Teachers and students were able to identify activities and experiences in Maldivian culture exhibiting measurement systems, and were able to link this to the conventional mathematics that is part of the Grade 5 measurement syllabus and vice versa.

Whether these indications of successes can be attributed solely to an ethnomathematical curriculum model, and whether they can be achieved by all teachers and all students is an open question. Two contributing factors could have been that the unit was new and therefore interesting and stimulating, or that the teachers and students reported what they thought were appropriate responses to the study. However, the detail of responses showed that an understanding of ethnomathematics and socio-cultural aspects of mathematics was emerging. The results also agree with those envisaged in the literature (e.g., D'Ambrosio, 2001; Zaslavsky, 1996). Further research needs to be done to fully understand the outcomes of extensive use of this approach.

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Author

Shehenaz Adam, School of Education, P.O. Box 756480, Fairbanks, Alaska 9975-6480, U.S.A. Email: <adam@math.auckland.ac.nz>; <ffasa@uaf.edu>; <shehei@hotmail.com>