Cultural connections and mathematical manipulations

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CULTURAL CONNECTIONS AND MATHEMATICAL MANIPULATIONS

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In the last 20 years there has been a growing literature dealing with ethnomathematical issues, or about studies involving culture and mathematics education. The growing community of those interested in the field held the *Third International Conference on Ethnomathematics* (ICEm-3) in February 2006, at the University of Auckland, New Zealand, convened by Bill Barton from the Department of Mathematics. ICEm-1 was in Granada, Spain, in 1998, organized by Maria Luiza Oliveras and entitled *Research, curriculum development, teacher education*. ICEm-2 was in Ouro Preto, Brazil, in 2002, organized by Eduardo Sebastiani Ferreira and entitled *A methodology for ethnomathematics*.

Here is an overview of ICEm-3, reflecting on the growth of the field and some key questions surrounding ethnomathematics and its significance for mathematics education. Did the conference meet the participants' expectations? Did anything new emerge? What are the challenges that now face the ethnomathematical community? There are various directions that can be taken for such an overview. We have attempted to identify categories of interest, rather than particular presentations – especially where these categories have shifted since the last conference. We have also looked for the questions that recurred during the conference, and the key themes that emerged, both as a result of the way the conference was designed, and serendipitously.

We have used the ICEm-3 theme – *Cultural connections and mathematical manipulations* – to interpret the many conference activities. We first present an analysis of participation, and then discuss the cultural connections made during the conference. Next the mathematical themes that emerged are presented, and finally the conference is viewed both retrospectively and with an eye to the future.

The presentations

There were 76 participants from 19 countries, with, newly, significant participation from Scandinavia, the Pacific and South Africa, as well as the usual large Brazilian contingent. During ICEm-3, 24 presentations were given. One third of these were from Asia or the Pacific, and the rest split evenly between North and South America, South Africa, and Europe. Six countries were represented in the plenary sessions:

1. Jerry Lipka, Dora Andrew, Evelyn Yanez (USA, Alaska): *A two way process for developing culturally based math: examples from math in a cultural context*
2. Indigenous Knowledge Panel. Willy Alangui, Chair (The Philippines); Dora Andrew, Evelyn Yanez (USA, Alaska); Salinieta Bakalevu (Fiji); Colleen McMurchy-Pilkington (New Zealand); Joel Martim (Brazil); Mogege Mosimege (South Africa)
3. Mathematical Workshop. Hariata Adams, Ngati Maniapoto (New Zealand): *Raranga Harakeke (Flax Weaving)*
4. Symposium in memory of Claudia Zaslavsky. Ubiratan D'Ambrosio, Chair (Brazil): *The work of Claudia Zaslavsky*; Maria Do Carme Domite (Brazil): *Indigenous intercultural program of education, elementary teacher undergraduate certification*; Kay Owens (Australia): *International contacts in ethnomathematics*; Lawrence Shirley (USA): *Ethnomathematics in global education programs*
5. Mathematical Workshop. Filipe Tohi (Tonga): *Lalava (Rope Lashing)*
6. Gelsa Knijnik (Brazil): *Ethnomathematics and the Brazilian Landless Movement*
7. Ubiratan D'Ambrosio (Brazil): *The scenario 30 years after*

To try to get an overview of the presentations, we classified them by the apparent preoccupation of the presenter, as well as by the subject-matter concerned. Six preoccupations emerged: mathematics learning; teacher education; politics; sociology/anthropology; philosophy/critique; and ethnomathematical theory development. The subject-matter of presentations was divided into four categories: the knowledge of a specific cultural group; academic mathematical knowledge; classroom mathematical knowledge; and ethnomathematics as a field (see Figure 1).

Author preoccupation (%)			**Paper subject-matter (%)**		
ICEm-	**2**	**3**	**ICEm-**	**2**	**3**
Mathematics Learning	40	50	Specific Group Knowledge	48	29
Teacher Education	12	8	Academic Mathematical Knowledge	7	4
Politics	10	8	Classroom Mathematical Knowledge	35	54
Sociology/ Anthropology	24	13	Ethnomathematics as a Field	10	13
Philosophy/Critique	7	8			
Ethnomathematical Theory	7	13			

Figure 1: Table showing classification of presentations by author preoccupation and subject-matter.

By far the majority of authors were preoccupied with mathematics education, although most were motivated by more than one preoccupation. The subject-matter was most often classroom knowledge, but a significant proportion dealt with the knowledge of a specific group. The groups represented in this work included: indigenous cultures from the Philippines, Mexico, Brazil, USA, and South Africa; national groups of Japan, China, Greece, and Israel; and the social groups of mathematicians and of nurses. Compared with ICEm-2, there has been a clear move towards educational issues, and a small shift towards theoretical issues. There is a lower proportion of anthropological studies of specific group knowledge.

Cultural connections

One way to describe the conference is to talk about the various kinds of cultural connections that were made during it. We can acknowledge at least four types: different indigenous groups talking with each other; academics intersecting with indigenous groups; mathematicians connecting with artists and mathematics educators; and the critiquers and advocates of ethnomathematics engaging in debate. These connections were not always easy because of language, philosophical tensions, or differing agendas. But they were always good-natured and, more importantly, extremely productive.

The conference opened with a *Powhiri* (formal Maori welcome) that was replied to by Joel Martim from the Guarani people of Brazil (see Figure 2).

Figure 2: Joel Martim in the Wharenui (Maori Meeting House)

With the first languages heard in the conference being two indigenous languages, the scene was set for a critical role to be played by indigenous representatives. This interaction was highlighted in the plenary panel on indigenous knowledge. Representatives from six groups talked about different political, practical, and schooling issues of ethnomathematics embedded in cultural knowledge as seen from the point of view of an indigenous person. This high degree of interaction amongst people from different countries continued in informal gatherings during the conference.

The effect was to draw indigenous perspectives into academic ethnomathematics. Nowhere was this better illustrated than in Willy Alangui's presentation of his work on the rice terracing in the Cordillera region of the Philippines. Willy is both an Igorot (indigenous Philippino), and Chair of the Department of Mathematics at the University of Philippines, Baguio. He introduced us to his idea of "mutual interrogation". Willy had collaborated with an applied mathematician to develop a model of water distribution over a system of rice terraces. He also examined the system in practice. He then set up a dialogue between the two systems, and found that each contained concepts that were not present in the other. This dialogue enhanced both the applied mathematician's understanding of modelling, as well as the rice farmers' understanding of water systems. Such a deliberate interaction between world-wide conventional knowledge and indigenous practice presents a new way to think about the task of ethnomathematics.

The conference allowed mathematicians, artists, teachers, and mathematics educators to explore the experiences and thoughts of each other's social-cultural groups. It was significant that the conference was hosted by NZ's leading university Mathematics Department and included interested and enthusiastic involvement on the part of some academic mathematicians. Interactions with craftspeople are described below, but, as with earlier conferences, the teachers present brought a practical focus. A wide range of teaching concerns were evident in papers on multicultural classrooms in Sweden, education of indigenous mathematics teachers in Brazil, language of instruction in Japan, a Mayan autonomous school in Mexico, and an ethnomathematical curriculum project in Alaska.

ICEm-3 saw the appearance of debates between critiquers and advocates of ethnomathematics. Kai Horsthemke and Marc Schäfer critiqued the conceptualisations and results of ethnomathematics from social, political, and epistemological viewpoints. They were concerned about the problems of relativism, whether all mathematical skills are culturally embedded, and the threat of marginalisation in a culturally named mathematics. While these critiques have appeared before in the literature, it is a measure of the scholarship of our field that these are welcomed at our conferences and generated considerable informal debate. Thus several movements were unleashed at ICEm-3 in terms of cultural connections – thereby meeting one of the aims of the conference.

Mathematical manipulations

The second subtitle of the conference gives another means to discuss its proceedings. There were two plenary workshops during the conference, and two presentation workshops: all four captured people's imagination and set participants reflecting on mathematical manipulations in the physical sense.

The plenary workshops were designed to give an experience of Maori and Polynesian craft that could have mathematical interpretations. In each case, the presenters were professional craftspeople and the mathematical part was done by the participants. The *Raranga Harakeke* (flax weaving) workshop took place in the University of Auckland *Wharenui* (Maori Meeting House), and the *Lalava* (rope lashing) workshop in the *Fale* (Pasifika meeting house). These beautiful ceremonial buildings exhibited many examples of craft and design other than weaving and lashing, and were inspiring places to engage with the depth of knowledge and skill that these crafts require.

The *Raranga Harakeke* workshop was preceded by a talk by the Maori weaver Hariata Adams that discussed the conventions of weaving, and we learned, for example, about the contemporary environmental issue of the disappearance of *pingao*, the grass used for the decorative panels in the *wharenui*. This reminder of the interconnection between craft with other aspects of life set the scene for a discussion about the origins and social importance of the conventions surrounding weaving. In the workshop we were able to undertake small weaving exercises of a much more creative nature than forming flat mats: flowers and fishes emerged from the long flax leaves.

Figure 3: A flax flower.

Mathematical discussions varied from the practical questions (how to form shapes and angles that were not the familiar rectilinear ones? how to create 3-dimensional objects? what are the limits on the mathematical shapes that could be formed?), to those about theory and context (how did weaving conventions relate to the knowledge being demonstrated?; what would be necessary to bring these practices into a mathematics classroom?; would these practices be useful in a mathematics classroom?).

The *Lalava* workshop was also introduced by a talk. Artist Filipe Tohi from Tonga – a well-known sculptor – described the ways he uses the ideas of lashing to develop the huge 3-D sculptures for which he is famous.

His emphasis on the 3-dimensional nature of the apparently 2-dimensional patterns formed during lashing, and his discussion of the construction of the shapes, took many of us by surprise. Not only were the effects visually stunning but the geometric complexity was much greater than expected, and the analysis fascinating. Some participants made links to third year university abstract algebra and to school geometry.

Discussions amongst participants concerned the mathematical aspects of these crafts, but often the talk became debates about the relationship between mathematics and craft and the consequences of decontextualisation or mathematisation when used in educational situations.

The other two workshops concerned origami and the Chinese abacus respectively. Again, our hands-on work generated conversations – this time much more firmly directed at educational outcomes and relationships with school mathematics curricula.

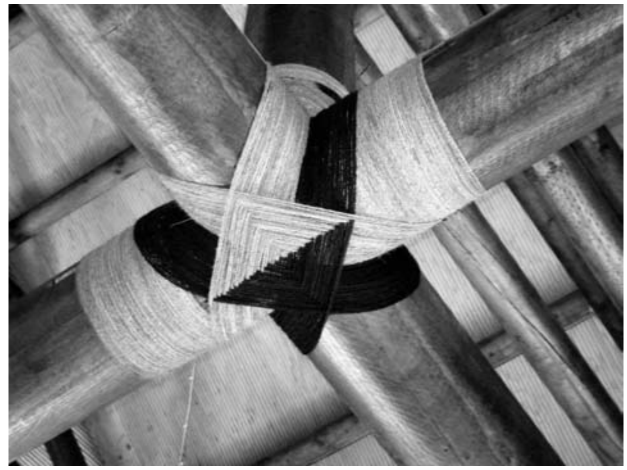

Figure 4: Lalava lashing.

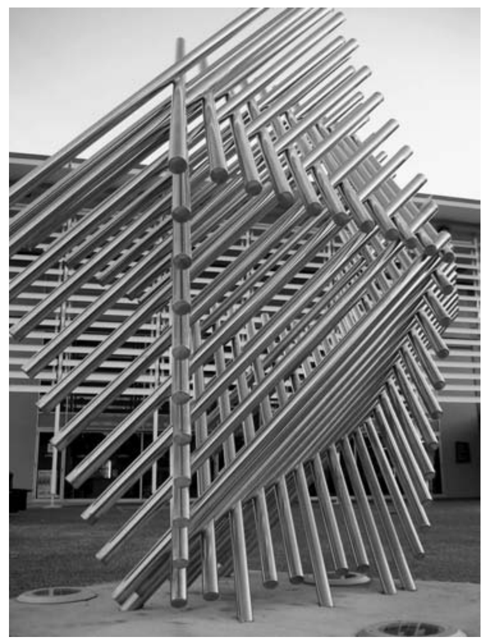

Figure 5: Tohi sculpture based on Lalava structures.

The abacus was handed out with no instructions, as it had been to children in a study reported by the presenter. We were asked to make sense of it as much as possible, and to hypothesise on the techniques of adding, subtracting, multiplying and dividing, reflecting on the way that the abacus could be used (or not) to develop ideas of place value. The group reproduced (so we were told) the stages that younger children go through in their understanding. One of the many discussions was about the enhancing potential of cultural instruments such as the abacus, but also reflected on the possibility that such instruments may have a closing down effect on other mathematical ideas.

The origami workshop involved models of strictly geometric shapes, with the intent of asking how and why these might be used in a classroom. The main presenter was an origami specialist with a huge range of techniques, and a repertoire that included complex geometric models.

A co-presenter had knowledge of the school mathematics curriculum, and discussed the use of this art form to fulfil conventional learning objectives. The discussions concerned helping each other when it was realised that what looked simple was not easy, and realising that the professionalism of all the craftspeople disguised a complexity that was almost impossible to reproduce just by watching.

Indigenous presentations

Mathematical manipulations also occurred in another sense. The conference began with a plenary session of Yup'ik Inuit cultural practices presented in the context of the curriculum development work carried out by Jerry Lipka and his team over a 25-year period. Evelyn Yanez and Dora Andrew discussed measurement systems for making clothing and for building, and demonstrated design techniques used by their elders.

During the conference, many other presentations described indigenous (and other cultural) practices that contain mathematical interest. Through the conference these experiences developed into discussions about the relationship between cultural practices and mathematics: how could one transform into the other?; can it be a two-way process?; what are the benefits and drawbacks of these transformations, both for the cultural practice and for mathematics?

There was also a later debate about whether the point of ethnomathematics was to enhance conventional mathematical understanding or not. Another presentation from the Yup'ik curriculum group provided comprehensive statistical evidence for the efficacy of ethnomathematical materials and approaches for students measured against the criteria of success in standard mathematics tests. While it was agreed that this evidence was a strong basis on which to pursue an ethnomathematical educational agenda, the idea that conventional mathematics should be the ultimate outcome was questioned. The aims of an ethnomathematical education were restated in terms of humanist principles in D'Ambrosio's final plenary talk: that mathematical knowledge is not isolated, but forms part of the fabric of society and must be taught so this is inherent.

Looking backwards and forwards

This was a smaller conference than ICEm-1 and ICEm-2. This had both advantages and disadvantages. On the one hand the intimacy provided more depth of discussion, and follow-up discussions with the same people. It also allowed participants to hear most presentations, with parallel sessions mostly having two presentations rather than the five at ICEm-2. On the other hand we missed the politically-oriented contributions from North America, and fewer new researchers attended – as can be expected in a country of low population density.

Reflecting back on the three conferences, the coverage of Europe, South America, and Oceania is an encouraging sign of the broad base of the field. Looking forward, the willingness of Lawrence Shirley to organise ICEm-4 in the USA, and Mogege Mosimege to work towards South Africa being the following venue, continue this trend.

But what can be said about the direction of ethnomathematical study? Ubiratan D'Ambrosio's final plenary was titled as a retrospective look, however, as is his habit, he had a lot to say about where we are heading. The predominant theme, accepted by the conference in general, was one of ethical values. It represents a turn away from studies of cultural practices as mathematics, now that the case has been made for a variety of systems of knowledge. Rather we need to be looking at more fundamental characteristics of knowledge systems – namely, their relationship with society. What can other knowledge systems teach us about that?

Ubiratan began by noting that history shows us that mathematics is (and always has been) intrinsically involved with actions that deny human life (for example, war and environmental destruction). He argues that mathematics, mathematicians, and mathematics educators cannot act free from consideration of issues such as national and personal welfare and security, governmental politics, economics, relations between nations, relations between social classes, and the preservation of natural and cultural resources. We are all deeply involved with these issues, and such issues affect humans and their relations with nature.

Ubiratan reinforced the links between mathematics and society by reviewing the roots of mathematical activity. Individuals create instruments (such as mathematics) to enhance the possibility of survival and the transcendence of time and space. In this search, people attempt to explain the phenomena they encounter. These models and explanations are an attempt to know (and control) the future. Such concepts implicitly include religious and value systems. These systems of knowledge are the essence of ethnomathematics.

One group of concepts, including classifying, ordering, comparing, measuring, quantifying, inferring, and inventing, when organised in a specific way with a specific set of values (for example, rationality) constitute what is called (Western) mathematics. It is widely agreed that, as a way of organising this set of concepts, mathematics is a universal mode of thought – just as survival with dignity is agreed to be a universal problem for humankind.

Ubiratan claims that we should establish a priority to look at the relations between these two universals, that is, at the role of mathematicians and mathematics educators in creating a civilisation with dignity for all, free of inequity, arrogance, and bigotry. He offers ethnomathematics as a proposal. Ethnomathematics is thus a project in the history and philosophy of mathematics with pedagogical implications. The pedagogical aims are to promote creativity in helping people reach their mathematical potential and citizenship by transmitting human values and responsibility within society.

Ubiratan acknowledged that we are currently in a state where critical views of mathematics education are meeting nostalgic and obsolete views of what mathematics is. This causes confusion between ethnomathematics and ethnic mathematics. The latter is characterised by ethnographic studies unsupported by theoretical foundations. He therefore proposes that we give more attention to the theoretical strand of the programme ethnomathematics as a research programme with pedagogical implications.

At a post-conference event, Ubiratan D'Ambrosio, Bill Barton, and Bengt Johansson recorded a two-hour discussion of what exactly this might involve. The trialogue will be the subject of a follow-up paper.