

MATHEMATICS EDUCATION AND SOCIETY: AN OVERVIEW

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ICMI has played an important role in giving impetus and space for the emergence and growth of the study of social, cultural, political and economic issues in mathematics education. These have spawned diverse areas of scholarship - such as the impact of gender and class, ethno-mathematics, critical mathematics education, equity and social justice - which have found expression in the scientific activities and programmes of ICMI. This paper is intended to provide an overview of the field and to introduce the other papers submitted to the working group. It is organised around three themes: conducting research, sites of structural disadvantage and the pedagogic implications of critical mathematics education.

INTRODUCTION

There has been an increasing recognition over the last two decades that the context in which learning occurs profoundly affects what is learnt and by whom. In much early mathematics education research, knowledge was conceived as being simply a property of the individual consciousness. The realisation that knowledge is produced in *situations* (Lave, 1988; Wenger, 1998; Lerman, 2000) requires us to move beyond an analysis of learning which is dependent on a psychological representation of the mind alone and to consider instead the setting – its social relationships, its cultural locality, the discursive frameworks available in the locale, the social and political environment which frames it – and how that setting functions generatively in the construction of knowledge. In other words, mathematics education research has taken 'a social turn' (Lerman, 2000:19). Indeed, as **Heather Mendick *et al*** state in their seminar paper, there is a recognition that mathematics education is *always already* social.

However, those researchers who are mostly likely to be found together in a forum focused on *Mathematics education and society* usually mean something more than this. Such researchers understand mathematics education as being a profoundly political activity – political in the sense of being intimately bound up with issues of power, authority and the legitimisation of knowledge: who is able to decide what happens, who is recognised as having the authority to set the agenda, whose interests are served by currently dominant conceptions of learning, whose voice 'counts', whose knowledge is deemed legitimate and authoritative and so on (Hardy and Cotton, 2000; Klein, 2002). Education is seen as being deeply value-laden, a moral activity. It follows that enquiry in mathematics education must engage with issues of social justice and that a fundamental role of mathematics education research is critique and transformation.

The papers being presented to the Working Group cover three inter-connected themes, many of the papers picking up more than one of them.

- A number of the authors are concerned with specifically methodological questions. What are the implications of an equity agenda for research methods and methodologies? Are there specific methodological implications for critical mathematics education researchers?
- Some authors take as particular focus one of the systematic sites of disadvantage in mathematics education. How do class, gender, 'race', ethnicity and global position - what has been called the North/South divide - impact on mathematics education? How are the sites of structural disadvantage conceptualised? How do they interact?
- A third focus, and the central concern of some of the papers, is the practices associated with teaching, learning and accrediting mathematics. What educational practices promote or inhibit a social justice agenda? What might a critical mathematics pedagogy look like?

This overview briefly considers each theme in turn and draws on the working group papers to illustrate and extend them.

CONDUCTING RESEARCH

As well as mathematics education itself, conducting mathematics educational research is also a political and moral activity involving issues of values, power, authority and legitimacy. Researchers interested in *Mathematics education and society* are likely to suggest that the aim of inquiry for social justice is 'the *critique and transformation* of the social, political, cultural, economic, ethnic, and gender structures that constrain and exploit humankind' (Guba and Lincoln, 1998: 211, original emphasis). Such a stance may have implications at a methodological level and a number of the contributors to this seminar make such methodological considerations a focus of their papers.

Research methods and methodologies are not neutral with respect to social justice; what are needed are approaches that explicitly acknowledge the politics of methodology and its impact on research (Vithal, 2003). Power differentials abound in the relationships between the researcher and the researched, with consequent questions about the status - an acknowledgement of the 'limits of knowing' (Walshaw 2002 p346) - and ownership of the tales that are told (Povey and Angier, 2006). In her contribution to this seminar, **Tansy Hardy** suggests an understanding of research as discursively and culturally constituted and explores the implications for how 'data' are read and how and which stories are told as a result, focusing, in part, on the discursive practices themselves. **Dave Wagner** is also concerned with 'storylines' but, in contrast, his paper draws on positioning theory and favours an approach where interpretation 'considers only the interactions of the immediate participants in

a conversation' since 'discourse systems are solely experienced locally through the medium of individuals in interactions'. He raises concerns about authority structures and about how communities are represented, illustrating these ideas by reporting on work with Canadian Aboriginal communities. He identifies colonial storylines and their connection with transmission metaphors for knowledge acquisition; and he contrasts these with 'more respectful' ones which show distributed agency.

Others who have become frustrated with mathematics education research which does not deal with social justice issues in a practical way have argued that there is a strong need to bring teachers into the research process and focus on issues of equity as they relate to classroom practice (Rousseau & Tate, 2003). The concern here is to avoid conducting research *on*, rather than *with*, teachers (Setati 2000). In her contribution to this seminar, **Merrilyn Goos** examines how teachers and researchers can work together in ways which allow genuine collaboration to be brought into being rather than in ways which simply serve the academic researchers' agenda. She draws on three, methodologically distinct, research projects to 'generate questions about the role of mathematics education research with respect to critique and transformation of the researcher and the researched'. The paper contributed by **Tony Cotton** is also concerned to critique and transform this accepted set of relationships:

Research in mathematics education is surely conducted for the benefit of teachers and the children they work with. Yet so often the voices of these key beneficiaries are marginalised within research to play the roles of clipped commentators allowed in only so long as they offer sound bites that sit neatly in the researcher's preferred story.

He suggests an alternative and more democratic purpose for mathematics education research, that of opening up spaces for marginalised or 'silenced' groups to be heard. He describes using new, more collaborative methods to enable researchers, teachers and pupils to 'speak to' both the academy and to those who form policy, methods which privilege experience over theory as a basis for understanding, allowing us to think how 'our worlds may be changed'.

A warning is given in the contribution from **Bill Atweh** about the complexity of achieving change in education. He argues that, 'in spite of the long history of research and practice, social justice remains under theorised in mathematics education'. He notes that, because mathematics acts as a gate-keeper for entry to many aspects of society, programmes have been developed to meet the needs of students who are deemed not to be engaging or not to be achieving as a result of factors of social background. He demonstrates some tensions between different possible understandings of social justice and associated practices; basing his argument on the writings of Nancy Fraser, he points up that such understandings and practices may achieve the opposite of what was intended.

The gap between desired change and the results of attempts to achieve it is also taken as a starting point in the paper from **Candia Morgan**, this time in the context of teacher development and pedagogical change. She argues that, currently, evaluation explanations of the gap tend to focus on the characteristics of the individual teachers involved; and there is an associated tendency to frame such explanations

in terms that suggest teacher deficit, often related to their pedagogic subject knowledge or mismatch between their beliefs and reform principles.

The paper argues for the value of a Critical Discourse Analytic approach which takes into account 'the social and cultural contexts in which innovation takes place', contexts which structure the sense-making of both teachers and students. The approach involves detailed attention to and analysis of texts produced by the full variety of participants in the educational system, texts which are likely to produce multiple competing discourses, with a view to understanding better the positions available to teachers and students and the impact of these on their identities and on how they engage with pedagogic innovation, transformation and change.

SITES OF STRUCTURAL DISADVANTAGE

It has long been recognised that neither education systems in general nor mathematics education in particular is neutral in terms of learners' positionings with respect to class, gender, 'race', ethnicity and global position. With respect to each of these (and other) positionings, some learners are systemically, structurally disadvantaged. For some of these sites, there is a considerable body of related mathematics education research; others have been more neglected. One key area of structural disadvantage which has been a focus of considerable research attention over the last few decades is that of gender (Barnes, 2000; Becker, 1996; Burton, 1999; Fennema, 1996; Forgasz *et al*, 2000; Grevholm and Hanna, 1995; Leder *et al*, 1999; Mendick, 2006). Much of this will be well known to ICMI participants since this concern led to the creation of the ICMI Affiliated Study Group, the International Organisation of Women and Mathematics Education (IOWME), which has been active for more than twenty years. During this time, the attainment profile for girls in mathematics has changed significantly in a number of countries but issues remain: young women opting out of mathematics; who identifies with mathematics and how; the ways that mathematics classrooms permit and perpetuate unhelpful stereotypes; and many more.

Other research has focused on 'race' and ethnicity (Atweh *et al*, 2001, Ladson-Billings, 1997, Powell, 2002); or on class (Frankenstein, 1990; Povey and Boylan, 1988; Zevenbergen, 1999; Lubienski, 2002). Others have specifically identified the issues of indigenous people coming to learn mathematics (Zevenbergen, Mousley and Sullivan 2004). Tate (1997) also draws on all these areas to identify the difficulties of multiple areas of disadvantage on the learning of mathematics. And,

through much of this research, these sites of structural disadvantage have been conceptualised as fundamentally interconnected (Keitel, 1998)

Structural sites of disadvantage form the focus for a number of the papers being presented at this seminar. **Dave Wagner's** paper points up both the difficulty and the possibilities of research in the contexts of indigenous peoples. Of his own work, he writes,

Colonialist storylines seem inevitable in this community that experiences the fallout of colonialism daily. Though respectful research and dissemination is challenging in such an environment, it can improve intercultural understandings.

Two other contributors also seek to research respectfully with the mathematics education experiences of indigenous peoples. **Robyn Zevenbergen's** seminar contribution is concerned with Indigenous students who live in remote communities in Australia. Alerted by PISA to the continuing profound inequality between different social, cultural and geographic Australian communities, she uses ethno-mathematical ideas to explore the tensions between school mathematics practices and the mathematical knowledge the students bring to school. The focus for **Gelsa Knijni's** seminar paper is the effect of 'regimes of truth' on adult Brazilian peasant mathematics education. She discusses how statements come to be made about what it is to learn mathematics in this social, political and cultural context and how such statements circulate in peasant pedagogical culture. She further reflects on the interconnections between such truths and school mathematics processes.

Two of the contributors to the seminar take as their context issues related to taking a global perspective. **Bill Atweh** illustrates his theoretical argument mentioned earlier with material from a study in the Asia Pacific region concerned with the internationalisation and globalisation of mathematics education: he draws on the views of mathematics educators from around the world to report on and develop understanding of collaboration projects between industrialised and less industrialised countries. **Paola Valero's** contribution draws attention to the fact that

mathematics education research, in general, has been operating in a reality that is far from being the reality of most classrooms in the world

She argues that mathematics education researchers, moving between utopia and reality and seeking to contribute to creating better utopias, need to give serious consideration to the reality of the vast majority of the world's mathematics classrooms. A research agenda is required which generates knowledge about what it is to teach and to learn mathematics in classrooms in situations of poverty and conflict.

The effects of class and home upon the lived experiences of pupils is the focus of the contribution from **Vanessa Roper and Peter Gates**. They use Bourdieu's concept of cultural capital to frame their analysis of two case studies of pupils near the beginning of their secondary schooling, exploring the factors which influence

success at school. They examine the influence of home and family, including socio-economic status and linguistic background, on mathematics attainment; they also consider the effects of schooling itself. The pupils' resulting mathematical learning trajectories are examined and the claim is made that what the pupils achieve in the future will, 'in all likelihood, be shaped by their social background'.

In their contribution, **Heather Mendick *et al*** argue that issues of gender, class and ethnicity are all deeply implicated in the construction of what is takes to be a mathematician. Drawing on a study conducted in England and Wales and based on group interviews with 15-16 year old school students and with humanities and mathematics undergraduates, they build up a picture of what it means to be a 'real' mathematician and of what it means to be mathematically 'able'. They write,

Participants' strong default image of a mathematician is of a white, middle-class man, and is associated with markings onto and into the body including states of clothing, posture and mental health ... It is apparent that particular mathematical stories stick to some bodies and slide off others.

They note that a process of Othering is at play and that the close connection between mathematical identities and inscription on the body makes current perceptions 'natural', thus cutting short social understandings.

Issues of identity and of how identity is performed are also concerns addressed in the paper from **Tansy Hardy**. She takes up the notion of subjectivity as a theoretical frame: 'this framing presents identification not as state but a process through which learners are constituted and through which, in often implicit ways, they constitute themselves'. Juxtaposing material from a wide range of sources - textual fragments, images from interviews, questionnaires, research journals, published research - and drawing on the lived experiences of pre-service teachers, she seeks to explore the ways in which ambiguities are caught up in the process of identity formation, the ways in which identity is constantly rearranged.

THE PEDAGOGIC IMPLICATIONS OF CRITICAL MATHEMATICS EDUCATION

If young people are to learn to think mathematically, to manifest mathemacy (Alro and Skovsmose, 2002), to develop as persons and to acquire those democratic competencies needed to live as citizens – critical consciousness, sustained and sustainable action and co-operation (Moreira, 2002) – there are implications for mathematics classrooms. They will need to be places where learners set up productive relationships with the process of coming to know. For many learners in mathematics classrooms these disciplinary relationships are fraught with difficulty. Mathematics is experienced as being only a body of already established abstract knowledge, always known and belonging to experts, a discipline which is 'without fuzziness or debateable results ... no experiment, no interpretation of evidence, no comparison of criticisms' (Rodd, 2002:2). Learning mathematics becomes only a

process of acquiring received knowledge of already existing rules and procedure and doing mathematics becomes performance. Rather, tasks are needed which can be approached in a variety of ways, and for which a wide range of tools can be offered as appropriate; which provide useful opportunities for learners to see themselves as active, as choosing, deciding, producing arguments for and against, assessing validity and generating questions and ideas. Such practices profoundly affect the nature of the resulting knowledge. How we know, and how we come to know, are inseparable from what we know.

The contribution to the seminar from **Ole Skovmose** deals with this directly. He is interested in the notions of critique and of critical mathematics education and, specifically, in their relationship to both uncertainty and possibility. He argues that mathematics 'operates as part of a world-wide distributed technical rationality', in everyday practices, in professional contexts and in technological enterprises in a complex web of social and political framings. It operates in a globalised economy with the accompanying locales of disadvantage and is implicated in the processes of inclusion and exclusion. Drawing on examples from developing world contexts, the paper attempts to formulate what a critical mathematics education for the future would look like.

In their contribution to the seminar, **João Filipe Matos and Madalena Santos** point out that research in mathematics education can contribute to help in understanding how different people organize their mathematical knowledge. They point to the ways in which both cultural studies and the ethno-mathematics tradition have provided accounts of 'the particular ways people organize, adapt and build up mathematical structures and forms of thought in order to make sense of everyday activities'; these will typically be very different from the ways validated by schooling. Currently in Europe there is a movement to recognise and accredit such experiential mathematical competences for the very many people who have not followed regular compulsory schooling; but the frameworks being devised for such accreditation seem only to be able to take schooling and academic learning as their reference point.

As well as setting up productive relationships with coming to know, and as part also of that agenda, social justice demands that teachers and learners set up productive relationships between and amongst themselves. Relational equity is the theme of **Jo Boaler**'s contribution to the seminar. She uses this term to 'describe equitable *relations* in classrooms; relations that include students treating each other with respect and responsibility'. Her report is based on a four year study in Californian high schools. In one of the study schools, a low-income, ethnically diverse, urban high school, the pupils learned to respect others in the class who were differently positioned with respect to cultural background, social class, gender and attainment level. In addition, their behaviour overall improved and they achieved better results, with differences in attainment between groups either reduced or eliminated

altogether. The classroom approach was multi-dimensional, nurturing 'social and intellectual commitment, communication, responsibility, and respect'.

CONCLUSION

In the interests of equity, there is a continuing and pressing need for research which advances our understanding of the issues related to mathematics education and society. The papers presented at the Working Group deepen our knowledge of the field and provide an enriched perspective on the possibilities for effective action for transformative change.

REFERENCES: PAPERS SUBMITTED TO THIS SEMINAR

- Atweh, Bill** Understanding and Practicing Social Justice in Mathematics Education
- Boaler, Jo** Promoting 'relational equity' through a mathematics approach focused upon social justice
- Cotton, Tony** Relationships to mathematics, relationships to learning mathematics.
- Goos, Merrillyn** Critique and transformation in researcher-teacher relationships in mathematics education
- Hardy, Tansy** Subjectivity as a tool to explore relationships to learning and teaching mathematics
- Knijnik, Gelsa** "Regimes of truth" on adult peasant mathematics education: An ethno-mathematics study
- Matos, João Filipe & Santos, Madalena** Recognizing and validating mathematical competences in adults: political and ethical dimensions
- Mendick, Heather, Marie-Pierre Moreau & Debbie Epstein** Embodying mathematics
- Morgan, Candia** Researching innovation in curriculum and pedagogy from a critical perspective
- Roper, Vanessa & Gates, Peter** The subtle but pervasive influence of class in learning at school. The case of mathematics
- Skovsmose, Ole** Critique as uncertainty
- Valero, Paola** In between reality and utopia: A socio-political research agenda for mathematics education in situations of conflict and poverty
- Wagner, Dave** Positioning theory and intercultural conversations about mathematics
- Zevenbergen, Robyn** Tensions, contentions and connections in learning mathematics for students of significantly diverse backgrounds

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