MATHEMATICS AND SOCIETY: A CONTRIBUTION TO *FRAME*

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Colleagues will see from a parallel group that CoPrIME and BSRLM are working towards defining a number of questions which research in mathematics education needs to address. Amongst the collections of issues to be identified are a number drawn together under the heading of Mathematics and Society. This paper will hope to explore some of these foci.

The FRAME mathematics and society group has considered concerns such as :

- Addressing the standards of inclusion and participation,
- Mathematics in educating a modern citizen and issues relating to mathematics as a social gatekeeper
- Institutional discrimination from ‘setting and streaming’ and lack of room for individual ‘idiosyncrasy’
- Institutional discrimination relating to various social groups
- Inappropriate public images of mathematics and hence ‘effective teaching ‘ in mathematics
- Stereotyped public beliefs of certain learning/teaching styles in mathematics
- Key skills and perceived needs

This paper looks at some of these issues and possible research questions are indicated in the text and presented at the end. Comments are welcome as this agenda is intended to be a developing process.

Mathematics has a special place in society, due to its long term traditional importance in all developed societies, and enhanced by its central role in science and engineering (Skovsmose, 2000). The impact of new technologies might eventually cause a re-appraisal of its significance. Mathematics is likely to remain an important ingredient in the creation of informed citizenry. There are frequently made statements reporting increased demands on thinking and problem solving skills, many of which are embedded in mathematical thinking. This places mathematics at the centre of any debate about equity and inclusion, increasingly significant issues as the world becomes more ‘global’ and societies more inter-dependent.

Mathematics is value–laden, it creates attitudes and assumptions which interact with human discourse and human relationships. It is critical, therefore, in any drive to increase standards of inclusion and participation. These ‘value-standards’ are at least as important as the academic standards at the centre of current education policy initiatives. This is even more vital on the global stage. At the opening session of ICME 9 serious concerns were raised in regard to the increasing technological divide which increasing dependence on the new technologies is likely to create. (Woodrow, 2001; Koblitz, 1996; Dubinsky and Noss, 1996). At a micro-level as well it does indeed increase the distance between those individual pupils with access and those for whom access in unavailable.

Failure in mathematics automatically excludes from certain roles in society - a subject like mathematics which divides and tiers pupils from an early age must ensure that such institutional discrimination does not put in place exclusive practices which mitigate against certain groups of pupils. Any mathematics teaching style may serve to exclude those who find other ways of learning more suited to their particular style, and the hierarchical structure of the mathematics curriculum makes it difficult to response to the variable and individual variations in rates of development. Denvir and Brown (1986) showed how idiosyncratic the individual tracks are in the learning of mathematics, and the pace of learning varies as learners develop at different rates at different times.

Another form of exclusion takes place through its use in official documentation and the media and the way in which those unable to access the mathematics within such reports feel unable to contribute to discussion and debate. Indeed one effect of general uncertainty about mathematics is not to challenge statistical information and to invest argument presented 'mathematically' with unreasonably validity. Borba and Skovsmose, 1997, and Stronach, 2001 explored the ways in which an 'audit culture' has set about converting educational values into measurable outcomes to create a market in reputations ('league tables', the RAE culture). Its outcomes can be seen in the TTA description of the mathematics which teachers need as that required to read PANDAs and other measures with little intrinsic meaning, provided as a rationale for the QTS tests in numeracy.

The varying achievements in education in England of pupils from differing ethnic groups have been well charted by Gillborn and Gipps (1998), Gillborn and Mirza (2000) and Pathak (2000). There is little research in U.K. on the reasons for the differences in attainment by pupils of different ethnic origins. Gillborn and Mirza indicate that for some LEAs Afrikan Caribbean pupils actually perform well at primary level but their performance seems to deteriorate during secondary education, clearly a matter for enquiry. Gillborn and Mirza point out, in passing, that the three-tier system of examination in mathematics severely limits the achievement of lower classified groups, disproportionately made up of pupils from non-European ethnic origins. Boaler, Wiliam and Brown (2000) indicate the generally negative effects of ability grouping in mathematics and comment on the social factors which help determine those groups. Mathematics education can encourage inequitable opportunities through the public/social commitment to setting and streaming, persistently ignoring research which demonstrates its ineffectiveness (Harlen, 1997; Boaler et al., 2000).

Specific ethnic-origin data for GCSE/A-level needs to be reviewed but the differing preference for mathematics and information technology amongst students can be seen in the UCCA statistics. Of Asian applications to H.E. 30% apply for 'Mathematics and I.T'. compared to 12% of the White applicants and 19% of the Black applications. These percentages hide significant details – especially differential gender attraction.

Ethnic origin of only Maths applicants is not provided, however the overall figures do suggest that specifically mathematics recruitment is somewhat different. In 2000 the Maths Applicants numbered 3925, comprising 2421 Men and 1504 Women. This represents 1.3% of all men applicants and 0.7% of all women applicants. Oldknow and Taylor (1999) indicate that currently about 25% of the 16-year-old cohort gain high grades in mathematics, but that less than 10% enter for A-level mathematics of whom almost 66% are successful, and indeed about 1% of A-level students actually enter University to study mathematics.

	BlCarrib'n	BlAfrikan	Bl Other	Indian	PakistaniBa	Bangladesh	Chinese	White
Men	17	21	16	31	34	30	25	12
Women	4	9	4	11	11	10	9	2

Maths. and I.T. Applicants 2000 (% of Ethnic Group)

The continued comparative lack of interest from female members of whatever ethnic origin remains a clear cause for concern since it does represent a reduction in real opportunity and disadvantage.

Alongside these concerns for gender and ethnicity there is a rekindling of interest in the effects of social class and poverty; Povey and Boylan (1998), Dunne and Cooper (2000) have written about mathematics and social class in U.K. and Payne and Bidle (2000) in the USA have connected poor achievement with poverty in both schools and pupils home context.

Given the more prescriptive curriculum of the National Numeracy Strategy it is important to consider ways of matching teaching to pupils learning styles. The research which does exist tends to show a need for variety of presentation and method. There are issues related to the inclusion of pupils with S.E.N. into a curriculum whose teaching styles may be inappropriate and disadvantageous to their individual needs.

There is an ‘old fashioned’ assumption about the skills required by people in modern society – old fashioned in the sense that in many occupations (as in everyday life) the impact of modern technology has changed the knowledge and skills demanded. Different appreciations are now necessary and these need mapping onto the school syllabus to provide an accurate and believable ‘shopping list’ of what young people should be required to learn.

Dench et al. (1998) explored employers perceived key skill requirements, but there was confusion between key skills and basic skills. There is a need too to explore employees perceptions. Galbraith and Haines (1999) explored the context of key numeracy skills and found that the use of spreadsheets was more important than other calculation contexts (mental arithmetic, pen and paper methods, calculators, graphic calculators or specialist software). Dench et al. (1998) in a large ESRC project also found that computer skills were the major influence on pay levels. They found that professional communication, problem solving and verbal skills had some influence but that numerical skills had little influence. Such findings support the major promotion of computer skills launched by the government but provide little support for any extension of the exclusive focus on numeracy to be continued into Key Stages 3 and 4.

RQ1: What epistemological and pedagogical criteria drive the design of digital technologies for mathematics education. What is the right 'balance' (for whom and when) of what can be done with the technology, and what should be done.

What are the variations in pupils' access to I.T., what are the factors which create these differences and in what ways can they be compensated.

RQ2: What are the fundamental social attitudes that all education seeks to encourage and in what ways can mathematics education contribute to those developments.

Ways need constructing to describe standards related to wider education principles and objectives (such as inclusion and participation) and the achievements of school mathematics in meeting these standards mapped.

Research is needed on the discourses through which to present to the 'public' the complex issues relating to learning and teaching of mathematics.

RQ3: How can central curricula models be structured to encompass local community priorities for education

RQ4: More research is needed to track the individual learning careers of pupils learning mathematics.

More research is needed into the reasons for gendered and ethnic group subject choices.

RQ5: More research is needed into the reasons why 'good pass' GCSE and 'A'-level students choose not to continue to study mathematics, encompassing attitudes, epistemological beliefs, learning preferences of students and the courses they are given.

Changes to the A-level structure need to be monitored for their effects on recruitment to mathematics degree courses.

RQ6: Research is needed on the learning styles perceived by pupils as being required in mathematics lessons and the match with their own preferred style.

Specific research is needed into whether the NNS enables or makes more difficult the inclusion of pupils with S.E.N.

Research is needed on how differences in learning preferences, learning speeds and learning pathways can be enabled within the national curriculum and especially within the National Numeracy Project.

More analysis is needed on categories of students who benefit or not from the National Numeracy Strategy.

RQ7: Further research is needed on the macro and micro hierarchical essentials in learning mathematics.

RQ8: What levels of mathematics knowledge, appreciation and attitudes are required at different levels of society to enable it to function without economic disadvantage. In what ways does this knowledge functionally contribute to the economic enterprise.

RQ9: Research is needed on the nature of the demands from all the stakeholders in the mathematics curriculum, a clearer assessment of keyskill needs and a mapping of ways in which the mathematics curriculum can support keyskill agendas.

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