Real world equity issues in the teaching of secondary mathematics

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I report on an initial study, which aims to ascertain teachers' opinions and practice relating to the place of real-world equity issues in the mathematics classroom and identify any barriers they perceive. Although academics have examined ways to implement a culture of critical mathematics education, it has also been suggested that there is little evidence of real world problems being addressed in the mathematics classroom. The National Curriculum states that mathematics is "for understanding the world, the ability to reason mathematically, and a sense of enjoyment and curiosity" which contrasts starkly with a 'back to basics' curriculum in which citizenship at Key Stages 3 and 4 has been disapplied. Initial interviews were held to investigate secondary mathematics teachers' beliefs in relation to classroom mathematics, critically addressing real equity world issues.

Keywords: Real world equity issues, Secondary mathematics teachers, Pedagogical priorities

Introduction

I define real world equity issues (RWEI) as issues which can be critically examined in the mathematics classroom and so allow pupils to be critically literate through mathematics. These issues could be related to unequal economic, political and cultural power. Historically mainstream mathematics education does not have a tradition of critically examining connections between mathematics as an area of study and its relation to issues of equity (Apple, 2000). Issues of equity have been addressed in a number of ways in the secondary mathematics classroom, but the fact that the challenges remain would suggest that the solutions have not been completely effective. In the next section I illustrate that equity in the mathematics classroom can not be achieved through a set of policies which, at best, might be implemented in a tokenistic way with the risk of embarrassing the pupils they are trying to help.

Equity issues in the Mathematics Classroom

In 2007 the National Curriculum recognised that mathematics is a subject that has a rich history and has been developed across the world (Chambers, 2008). As a result the curriculum emphasised the importance of pupils learning mathematics in cultural and historical contexts. Chambers (2008) describes how, in order to demonstrate that mathematics was a worldwide activity, different mathematical patterns and calculation methods from various cultures were introduced into some classrooms. However, Chambers (2008, p.150) comments that at best this has been a "bolt on to the normal curriculum" and, at worst, completely ignored. In relation to this Lerman (1994a, p. 99) says "many topics introduced under this umbrella (multiculturalism) have served

quite the opposite function to that intended by the teachers. They can be extremely patronising and, although not intentionally, can make other people appear backward and primitive; they can embarrass children from ethnic minorities instead of engaging their interest".

Lerman (1994b) gives a similar example in the context of social class. Referring to examples in school textbooks, which had been revised with the intention of addressing equal opportunities and removing gender and race bias, he commented that strong social messages were conveyed in the texts. The books, aimed at 14 year-old pupils, had been divided into 'ability' sets. Using the example of an income tax question Lerman (1994b) explains how the lower ability question is dominated with pictures relating to leaving school and unemployment, whereas the high ability question depicts a white male civil servant working with piles of money. The earnings used in the texts are also different with the lower ability questions referring to earning of up to £9000, and the higher ability questions containing a table of tax rate bands and including questions with referring to incomes of £50,000. The questions have made assumptions that 'low ability' mathematics relates to low career expectations and poor salaries.

There is also clear evidence of a growth of interest in adopting diverse social practices into mathematics education, as illustrated in 'The Social Turn in Mathematics Education Research' (Lerman, 2000). These include a cross-cultural view on mathematical practices (Bishop, 1988), sociocultural basis for mathematics education (D' Ambrosio, 1985), critical mathematics education (Skovsmose, 1990) and sociology and mathematics education (Dowling, 1998). However, experiences of student teachers suggest that schools are reluctant to take risks and encourage such learning processes (Ghosh, 2002).

Method

I interviewed mathematics teachers to ascertain their opinions and practice in relation to RWEI and its place in secondary mathematics. The interviews prompted discussion about the participants' mathematical beliefs and their pedagogical priorities. Further, as mathematics teachers are now entering the profession from diverse academic backgrounds, I also wanted to investigate if there is any difference in opinion between teachers from non-mathematical backgrounds compared to teachers from mathematical backgrounds.

Instrumentation

Handal (2003, p. 47) asserts that "the range of teacher's mathematical beliefs is vast since a list would include all teachers' thoughts on personal efficacy, computer, calculators, assessment, group work, perceptions of school culture, particular instructional strategies, textbooks, students' characteristics and attributional theory, among others." However, Ernest (1991) outlined a more refined grouping of five different mathematics related belief systems that, it is inferred, can be found amongst teachers (Figure 1).

TEACHER AIMS AND BELIEFS	RANGE OF TEACHERS' MATHEMATICS-RELATED BELIEF-SYSTEMS				
	1 AUTHORITARIAN	2 UTILITARIAN	3 MATHS-CENTRED	4 PROGRESSIVE	5 SOCIALLY AWARE
THEORY OF MATHEMATICS	A collection of facts and rules	Unquestioned body of useful knowledge	Structured body of pure knowledge	A process view: a personalized activity	A socially constructed practice
AIMS OF MATHEMATICS EDUCATION	Back-to-Basics: numeracy and strict social training (repressive)	Useful maths to appropriate level certification vital (industry-centred)	Transmit body of pure mathematical knowledge (maths-centred)	Creativity, self-realization via mathematics (child-centred)	Critical awareness and democratic citizenship via maths (emancipatory)
THEORY OF LEARNING MATHEMATICS	Hard work, effort practice and rote the only way	Skill acquisition and practice, practical experience	Understanding and application key to progress	Activity, play exploration all central	Questioning and negotiating meaning essential
THEORY OF TEACHING MATHEMATICS	Authoritarian transmission drill, no frills	Skill instructor motivate through work-relevance	Explain, motivate pass on structure of knowledge	Facilitate personal exploration protect from failure	Discussion, conflict questioning content and pedagogy.
THEORY OF ASSESSMENT IN MATHS	Formal testing of basics, prevent cheating	External tests and certification skill profiling	External examinations based on hierarchy	Teacher led informal assessment avoid failure	Negotiated and non-competitive assessments

Figure 1. Range of teachers' mathematics-related belief-systems (from Ernest, 1991, p. 61)

However according to Ernest (1991) the model is intended to exemplify a development of quality from position 1 to 5 associating 'quality' with the constructivist approach.

I adapted Ernest's model by eliminating the progressive nature of the table (Figure 1) and transferring each statement onto individual cards in order that they could be used to prompt discussions throughout the interview (Figure 2). In considering Ernest's model I acknowledge that he recognises that it makes many assumptions and will be seen as too simplistic. However, the model is theoretically well grounded and offers appropriate prompts for more detailed discussions in an interview about mathematical beliefs and pedagogical priorities.

Figure 2. Range of teachers' mathematics-related belief-systems transferred into individual sort cards

Dowling and Brown (2010) advise that although such prompts involve suggesting possible responses and interrupt the spontaneity of the interview, this does not mean that they should be avoided and, for particular types of interviews, they may be crucial. I used the prompts to guide my participants into thinking and talking about their mathematical beliefs, something that it is never easy, particularly when the participant has had no time to prepare. Further, as my participants may have non-mathematical degrees it might be difficult for them to articulate their mathematical beliefs in response to an open question. Therefore, I presented the statements as a set

of cards grouped under the categories listed in Ernest's model, on the left hand column of Figure 1. The cards in each category (Theory of mathematics, Aims of mathematics education, Theory of learning mathematics, Theory of teaching mathematics and Theory of assessment in mathematics) were a different colour and participants had to choose the cards which reflected their belief system. Participants could choose more than one card from each category and place them in order of importance. It was important that all prompts were used in a consistent way with all interviewees (Robson, 2002). The first part of the interview was based on the responses from the card activity, asking participants the reasons behind their decisions; however, in order to achieve more in-depth responses I asked further questions as appropriate.

Interview

In this paper I will present the findings from an initial interview with one of the participants. I gave the cards to participants and asked them to study the cards under each heading and choose those they felt reflected their own mathematical beliefs. I explained that they could choose more than one card, but did not have to choose any if they felt no cards were suitable. They were free to discuss beliefs that were not on the cards and I also encouraged them to talk about cards they had decided not to choose.

Jenny - Interview

Jenny had an initial hesitation explaining that she had a History degree and felt she would not be able to offer much in the way of her mathematics-related beliefs. On reemphasising to her that I was particularly interested in the mathematical beliefs of participants who had non-mathematical degrees, she was comfortable about participating in the study.

Theory of mathematics

Jenny was clear that mathematics is 'a socially constructed practice' and, indeed, that everything is socially constructed. She dismissed the phrases 'unquestioned' and 'pure knowledge' and 'a collection of facts and rules' as against her beliefs about knowledge in general and said that the 'idea of 'not questioning something' is a strange one'. When Jenny reflected on the context of the school's approach to the theory of mathematics, she felt this to be very much at odds with her beliefs as she felt that the approach practiced in school was based on 'a collection of facts and rules and an unquestionable body of useful knowledge'. However she did emphasise that it was 'not so much the school as secondary mathematics in Britain'.

Aims of mathematics education

Jenny's beliefs about the aims of mathematics education included beliefs from both the 'authoritarian' and 'socially aware' areas of the model. However there was an implication that 'back to basics numeracy' was more suitable for the low achieving groups:

> J: I like the 'creativity and self realisation'. Even though there is a lot of practical purpose to mathematics I don't think education should be just for pragmatic and economic purposes, I do think it is about increasing someone's self awareness and making them stronger and better and enlarging their own possibilities, but along with that 'back to basics' numeracy is essential for the society we have created. However we are not teaching 'back to basics numeracy' to my Year10 Set 4, and some would say it was the most useful thing for them. They are actually getting everything.

> S: *What do you mean by everything?*
>
> J: They will be doing angle theorems, algebra or abstract thinking even though they struggle with number and division.

Theory of Teaching mathematics / Theory of Learning Mathematics

Jenny felt there was a conflict between her beliefs of teaching mathematics and how she was teaching at the moment. This is exemplified in the following extract:

> J: I think this is a difficult one as it is balancing how I would like to teach mathematics between how I have to teach mathematics. At the moment I have to use 'transmission, drill and no frill' and 'motivating through work relevance', it's not how I would like to teach it but it's difficult to do otherwise because of my inexperience. I would like to have 'discussion' and 'conflict question and pedagogy'. I think that will be a lot more engaging for students, it would facilitate their learning a lot better; if I tried to do that it wouldn't work.
>
> I'm confused with 'facilitate personal exploration, protect from failure'. I wouldn't agree with that, failure is the mother of success. So definitely 'conflict question and pedagogy' first and also partially 'explain motivate and pass instructional knowledge'.

In response to a question about the prominent prevailing beliefs of the school she worked in, Jenny identified several differences, and some similarities, in the beliefs relating to the theory of teaching and learning mathematics.

> J: *(talking about the prominent beliefs within the school)*: ''Practice and rote' with 'Understanding and application' and 'activity', not questioning , but I would say that there is a lot of 'practice and rote'.

Reflecting on this she also explained how, in the theory of learning mathematics, she felt she was stuck on 'practice and rote' and perhaps it was 'understanding and application', 'activity, play and exploration' and 'questioning' which were 'key in being able to integrate an idea in mathematics into your personal world'.

Theory of assessment

Here Jenny felt that all the beliefs had a purpose.

> J: All of these have a purpose 'external test and certification' are essential for the qualification of a job, 'Negotiated and non-competitive assessments' are perfect for people who genuinely enjoy mathematics'. 'Teacher led informal assessments' - what needs to be done and what levels some are working at. 'Formal tests' are essential if you want to see if they are making progress. I would say they all have a purpose.

She felt that external tests and formal testing of basics were the prominent method of assessment in the school and that 'you can't really not do those'.

Conclusion

Although it is not possible to draw any real conclusion from the initial interviews[1],

[1] A total of two interviews were taken at this initial stage, although data from only one of the interviews has been included. The conclusion is based on data from both interviews.

the experience, so far, suggests that some teachers could find integrating RWEI into their teaching of mathematics very difficult if their peers and schools are not favourably disposed toward this approach. These factors also create a potential conflict between teachers' pedagogical priorities and that of the context in which they teach. It may well be that teachers need to be further exposed to these ideas by initial teacher training institutions in order that they have the confidence to work against the grain in their schools.

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