MATHEMATICS TEACHER BELIEF SYSTEMS: EXPLORING THE SOCIAL FOUNDATIONS

Peter Gates

University of Nottingham, UK

Abstract

There is a considerable literature on teachers' beliefs and conceptions and their effect on the teaching of mathematics, but much of this literature either is located within a psychological paradigm, or where a more eclectic perspective is adopted, fails to locate the sources of beliefs in the social world. In this paper I look at some of the present models and approaches to teacher belief systems and argue that these can only give us an incomplete picture leaving as they do, the source of belief systems in the social world unexamined or unproblematised. I offer some sociological concepts that can help us understand better how belief systems are constructed upon teachers' ideological foundations.

The social role of mathematics education

Naturally there is diversity and variety in all mathematics teaching – a diversity that finds its rationale in mathematics teachers' belief systems. While what teachers do is based upon what they believe – what they do has both unintended as well as intentional consequences. It can hardly be contested that we live in an uneven and unjust society where access to education and to justice depend on the capital one can appropriate and accumulate. There is so much evidence in the literature to support this contention that it is hardly now contentious. Injustice is a process that goes on all around us, even when - and arguably especially when - we do not look for it or recognise it. Mathematics plays a significant role in organising the segregation of our society, as Sue Willis cogently argues:

> Mathematics is not used as a selection device simply because it is useful, but rather the reverse.
>
> (Willis 1989, p 35)

In other words, mathematics education plays its part in keeping the powerless in their place and the strong in positions of power. It doesn't only do this through the cultural capital a qualification in mathematics endows on an individual. It does this through the authoritarian and divisive character of mathematics teaching. Mathematics thus performs a social function, and by engaging in mathematics teaching, teachers are consequently involved in a social function. Hence in order to understand better the nature and functioning of mathematics teaching we need to look for foundations, predilections and structuring frameworks that would support a social model for understanding the discipline. Such an approach requires us to locate ourselves within

a dynamic and dialectical analysis of the relationships between human agency – the will of the individual – and social structure – the wider enabling and constraining forces operating on us. Indeed, it requires us to look for social forces not only as acting *on* us, but also as acting *in* us. Karl Mannheim takes this argument a little further.

> Strictly speaking it is incorrect to say that the single individual thinks. Rather it is more correct to insist that he participates in thinking further what other men have thought before him. He finds himself in an inhabited situation with patterns of thought which are appropriate to this situation.
>
> (Mannheim 1936 (2nd Edition 1952), p 3)

There is much evidence to suggest that school mathematics has a firmly established cultural tradition. This "*school mathematics tradition*" (Cobb, Wood, Yackel*, et al.* 1992) can be classified as teacher centred, where classroom routines incorporate the introduction of a new technique, presentation of examples and setting of exercises. In this routine, the teacher does most of the talking, directing and instructing pupils. Mathematics is presented as little more than replication of procedures demonstrated by the teacher (Brown, Cooney and Jones 1990) with a focus on memorisation and drill making the subject dull and uninteresting (Ball 1990, p 12). This characterisation of mathematics teaching is not only widespread (Romberg and Carpenter 1986), but is also historically persistent as a dominant model over the past 100 years (Cuban 1984). In addition, this pattern has been described as "*the most consistent and persistent phenomena known in the social and behavioural sciences*" (Sirotnik 1983, pps 16 – 17). There is considerable evidence that curriculum innovations become largely incorporated into teachers' existing teaching approaches and styles. Furthermore there is evidence that teachers portray their own teaching as more open than it might be described objectively (Edwards and Mercer 1987). This is a serious situation, which requires us to look for creative explanatory models of human behaviour.

Jeff Gregg has reported a study into the reasons for the persistence of the school mathematics tradition (Gregg 1995a, b). Synthesising research over the past 20 years, he suggests, "*there are certain beliefs about mathematics and its teaching as well as certain classroom practices that are taken-as-shared by many in our society*" (Gregg 1995b, p 443). He claims the hegemonic nature of these beliefs may be responsible for the widespread failure of the history of reform in mathematics education. Jeff Gregg describes a process whereby not only are teachers socialised into a culture of teaching, but "*teachers, students and administrators actively participate in the production and reproduction of these processes*" (Gregg 1995b, p 461). He suggests that by separating teaching from learning, and adopting a view of ability as capacity, teachers are able to act without questioning the taken-as-shared beliefs and practices of the dominant school mathematics tradition (Gregg 1995b, p 462). Whilst Jeff Gregg's study and analysis is a useful insight into the acculturation of mathematics

teachers, what he lacks is an explanatory framework for understanding the nature and roots of the phenomenon he describes. To provide this, we need to look more deeply into the organisation and source of teacher belief structures.

Mathematics teacher belief structures – some theoretical limitations

Studies of teacher beliefs often focus attention on beliefs as if they existed in a social and political vacuum drawing fundamentally upon a psychological paradigm, which seems unable to account adequately for the difficulties of teacher change. However, as the Centre for Contemporary Cultural Studies has suggested, beliefs do not exist in a social vacuum:

> If we are interested in the ways in which consciousness is formed, we cannot stop at the level of lived beliefs. Beliefs, conceptions and feelings are not only carried in the minds of human subjects; they are also written down, communicated, 'put into circulation', inscribed in physical objects, reproduced in institutions and rituals and embodied in all kinds of codes.
>
> ((CCCS) 1981, p 27 - 28)

Hence, beliefs have a wider and deeper dimension, rooted in cultural norms and forms that are themselves rooted in social structure. These have a huge influence over consciousness and ideology, setting many agendas and putting boundaries around what is considered as possible, describable or even legitimate.

Studies of teachers' belief and knowledge structures have increased considerably during the 80s and 90s. Kenneth Zeichner, Robert Tabachnick and Kathleen Densmore (Zeichner, Tabachnick and Densmore 1987) suggest that we need to consider adopting approaches to teacher development that recognise the complexity of the nature of knowledge (Zeichner, Tabachnick and Densmore 1987, p 24). They identify a lack of consensus in the literature on teacher socialisation and challenge the view that student teachers change and modify their views on teaching through experience and teacher education. Rather what happens is an elaboration of previously existing perspectives and a selective focus on experiences that validated their own perspectives. Again providing evidence for the inherent stability of belief systems.

Thomas Cooney and his associates have worked for some time on the knowledge and beliefs of preservice secondary mathematics teachers. They recognise that beliefs about mathematics and how to teach it are influenced by experiences with schooling long before prospective teachers enter professional training and that these beliefs seldom change (Brown, Cooney and Jones 1990). Such a worrying state of affairs requires us to try to understand therefore not just what it is that teachers believe, but how these beliefs are structured and organised (Cooney, Shealy and Arvold 1998).

Alba Thompson worked for a number of years on mathematics teacher beliefs. She claimed that teachers' patterns of behaviour characteristics are a result of consciously

held beliefs acting as a '*driving force*'. In addition, practice can be the result of unconscious beliefs and intuitions (Thompson 1984). What is unclear is the nature of these '*driving forces*', where they emanate and how they become operationalised. Alba Thompson suggested that more research was needed on the stability of teacher beliefs.

This phenomenon of teachers modifying new ideas and practices by adapting them to fit existing practices is now well understood (Thompson 1992, p 140). Underlying this problem is the issue of stability of the structures of commitment that we hold as individuals acting within a social world. This is an example of the difficulty in changing deeply help ideological dispositions and underpinnings. We may change words, we may change the context to (pseudo) real life situations, and we can even change the architecture of the school buildings, but little changes in the relations of power and domination in the mathematics classroom. "*Unfortunately the literature on teacher change, though rich with tips, does not offer explanations for this phenomenon*" (Thompson 1992, p 140).

Alba Thompson reviewed much of the research on mathematics teacher beliefs (Thompson 1992) yet it becomes clear in her review that much of the driving force in this research comes from the belief that it is the *teacher's view of mathematics* that is responsible for classroom practice. Such a view is typically represented by two comments:

> One's conception of what mathematics *is* affects one's conception of how it should be presented. One's manner of presenting it is an indication of what one believes to be most essential in it. The issue then is not, what is the best way to teach it, but what is mathematics really about?
>
> (Hersh 1986, p 13)

> All mathematical pedagogy even if scarcely coherent rests on a philosophy of mathematics.
>
> (Thom 1973, p 204)

These positions need to be questioned and deconstructed. Without further clarification, one reading is that one's conception of mathematics is the deciding factor in structuring one's teaching. Rene Thom seems to go further in using the word '*rests*' – a spatial metaphor that has a sense of dependency embedded in it. He question this begs is – on what does ones philosophy of mathematics itself rest.

Teachers' social perspectives – the missing dimension?

Much research undertaken on various aspects of teacher beliefs tends "*inadequately to explore teachers' social beliefs*" (Liston and Zeichner 1991, p 61). Teachers' *social* knowledge

> tends to be inadequately addressed in most accounts of teacher knowledge, is rarely examined in teacher education curricula and is awkwardly handled in the prominent models for cultivating reflective thinking and action in teachers.
>
> (Liston and Zeichner 1991, p 61)

As social beings, mathematics teachers do not come to the classroom devoid of social and political motives and intentions. Yet nor can we merely append '*social knowledge*' to a growing list of categories of professional knowledge alongside 'knowledge about children', 'pedagogical content knowledge' etc. because of the fundamentally constitutive nature of social beliefs.

In developing a theoretical framework, we need to be able to conceptualise this dialectical relationship between the individual and the social. Pierre Bourdieu offers a way through this in his appreciation of the interplay between objective social structure and subjective personal dispositions, which forms the central methodological and conceptual organisation of his work and informs his empirical studies (Bourdieu 1972, 1990b). It is his assertion that objective structures are actualised and reproduced through subjective dispositions (Bourdieu 1972, p 3). This does not mean that subjective dispositions have a primacy over more objective social structures. Rather that the development of individual dispositions is influenced and constrained by objective structures, the nature of hierarchy, the form of hegemonic positions and so on, which in their turn reinforce the objective structures. What distinguishes Pierre Bourdieu's approach is the way in which social structural properties and social and economic conditions are always embedded in everyday lives and events of individuals (Harker, Mahar and Wilkes 1990, p 8). Of course implicit in here is a readiness to accept that:

> There exist in the social world itself, and not merely in symbolic systems, language, myth etc. objective structures which are independent of the consciousness and desires of agents and are capable of guiding or constraining their practices or their representations.
>
> (Bourdieu 1990a, p 14)

Within this framework, there are two main conceptual tools that can be incorporated into research on teachers' beliefs that will give us access to some previously un-illuminated routes to the roots of the systemic logic of teachers' belief and values systems – the *habitus* and ideology.

Habitus

For Pierre Bourdieu, this symbiosis can be examined and understood through the elaboration of the *habitus*. I explore this in more detail, theoretically and empirically, elsewhere (Gates 2000), but briefly, the *habitus* is the cognitive embodiment of social structure. Our *habitus* forms the generative principles that organise our social practices leading to social action and provide us with systems of dispositions that

force us (or allow us) to act characteristically in different situations. The *habitus* thus resides within patterns of interactions and needs to be explored using techniques that dig deep enough into the logic underpinning the observable practices - a logic that is interwoven with the social origins of one's predispositions.

The mathematics teacher's *habitus* will be at the root of the ways in which teachers conceptualise themselves in relation to others; how they enact and embody dominant social ideas and well as how they transform and adapt them. The *habitus* is at the bottom of how we react, judge and evaluate.

Working with the *habitus* though is not enough. To help us understand the social foundations of mathematics teachers we have to look also at how the *habituses* of groups of teachers gel into ore organised forms of thinking and cooperation. Teachers become pulled together or 'interpellated' into social groupings and formations through the sedimentation of the individual *habitus* and predispositions into more socially organised ideological frameworks.

Ideology

Fundamentally, what distinguishes ideology from general sets of ideas is that ideology is about the relationship between ideas and society and the relationships between individuals. What typifies ideological ideas is their relation to the conflictual nature of economic and social relationships. Ideology thus relates to matters of power and social structure as well as relating ideas and activity to the wider socio-cultural context Hence, looking for ideological underpinnings require us to look at language forms used, to explore the social imagery adopted, to elaborate on how individual teachers categorise and organise their ideas especially in relation to others. These in particular will need to connect with ideas on the nature and form of society and how it operates. In addition, these will need to be tied to issues of practicality, which embody relations of domination. Relating this discussion to teaching, ideological underpinnings appear as ideas and assumptions about human nature, about learning and educational difference, the role of education, the role of the teacher and ideas about priorities for teacher professional development. Ideology can thus be represented as relatively stable, deep structures of ideas. Our ideological makeup, establishes us as being the same as and different from the individuals and groups with whom we associate or work – but a positioning process founded not upon some philosophy of mathematics, but upon one's social frameworks.

Conclusions

I am arguing here that while strictly psychological models of teacher beliefs can give us considerable insight into the structure of teachers' knowledge, they have some limitations when we come to want to look at some of the wider and possible unintended consequences of the education system. This can be informed by adopting models of belief systems as well as research techniques that look at how an individual constructs a system of beliefs both structurally and temporally. As researchers it

requires us to go beyond the data of observable practices and into the realms of those patterns and generative principles of which the teachers themselves may not even be aware. Underlying such an approach is the ideological predisposition that sees thinking as a social act, and systems of beliefs as representing dominant and objective social structures as well as helping those structures to operate and reproduce.

References

Ball, Deborah (1990) "Breaking with Experience in Learning to Teach Mathematics: the Role of a Preservice Methods Course", *For the Learning of Mathematics,* Vol: **10**, No: 2, pps 10 - 16.

Bourdieu, Pierre (1972) *An Outline of the Theory of Practice, (Translation of Esquisse d'une theorie de la practique, translated by Richard Nice, 1977)*, Cambridge, Cambridge University Press.

Bourdieu, Pierre (1990a) *In Other Words: Essays Towards a Reflexive Sociology, (Translated by Matthew Adamson)*, Cambridge, Polity Press.

Bourdieu, Pierre (1990b) *The Logic of Practice, (Translation of Le sens pratique, by Richard Nice 1980)*, Cambridge, Polity Press.

Brown, Stephen, Cooney, Tom and Jones, D (1990) "Mathematics Teacher Education" in Houston, Robert, Haberman, Martin and Sikula, John (Eds.) *Handbook of Research on Teacher Education*, New York, Macmillan, pps 639 - 656.

(CCCS), Centre for Contemporary Cultural Studies (1981) *Unpopular Education. Schooling and Social Democracy in England Since 1944*, London, Hutchinson.

Cobb, Paul, Wood, Terry, Yackel, Erna and McNeal, B (1992) "Characteristics of Classroom Mathematics Traditions: an Interactionist Analysis", *American Educational Research Journal,* Vol: **29**, No: 3, pps 573 - 604.

Cooney, Thomas, Shealy, Barry and Arvold, Bridget (1998) "Conceptualising Belief Structures of Preservice Secondary Mathematics Teachers", *Journal for Research in Mathematics Education,* Vol: **29**, No: 3, pps 306 - 333.

Cuban, Larry (1984) *How Teachers Taught: Constancy and Change in American Classrooms, 1890 - 1980*, New York, Longman.

Edwards, Derek and Mercer, Neil (1987) *Common Knowledge. The Development of Understanding in the Classroom*, London, Methuen.

Gates, Peter (2000) *A study of the structure of the professional orientation of two teachers of mathematics: a sociological approach*, unpublished Ph.D. thesis, University of Nottingham.

Gregg, Jeff (1995a) “Discipline, Control, and the School Mathematics Curriculum”, *Teaching and Teacher Education,* Vol: **11**, No: 6, pps 579 - 593.

Gregg, Jeff (1995b) “The Tensions and Contradictions of the School Mathematics Tradition”, *Journal for Research in Mathematics Education,* Vol: **26**, No: 5, pps 442 - 466.

Harker, Richard, Mahar, Cheleen and Wilkes, Chris (Eds.) (1990) *An Introduction to the Work of Pierre Bourdieu. The Practice of Theory*, Basingstoke, Macmillan.

Hersh, Reuben (1986) “Some Proposals for Revising the Philosophy of Mathematics” in Tymoczo, T (Ed.) *New Directions in the Philosophy of Mathematics*, Boston, Birkhauser, pps 9 - 28.

Liston, Daniel and Zeichner, Kenneth (1991) *Teacher Education and the Social Conditions of Schooling*, London, Routledge.

Mannheim, Karl (1936 (2nd Edition 1952)) *Ideology and Utopia*, New York, Harcourt, Brace and Wold.

Romberg, Thomas and Carpenter, Thomas (1986) “Research on Teaching and Learning Mathematics: Two Disciplines of Scientific Inquiry” in Wittrock, Merlin (Ed.) *The Handbook of Research on Teaching*, New York, Macmillan, pps 850 - 873.

Sirotnik, Kenneth (1983) “What you see is what you get - consistency, persistency and mediocrity in classrooms”, *Harvard Educational Review,* Vol: **53**, No: 1, pps 16 - 31.

Thom, Rene (1973) “Modern Mathematics: Does it Exist?” in Howson, Geoffrey (Ed.) *Developments in Mathematical Education: Proceedings of the Second International Congress on Mathematics Education*, Cambridge, Cambridge University Press, pps 194 - 209.

Thompson, Alba (1984) “The Relationship of Teachers' Conceptions of Mathematics and Mathematics Teaching to Instructional Practice”, *Educational Studies in Mathematics,* Vol: **15**, No: 2, pps 105 - 128.

Thompson, Alba (1992) “Teachers’ Beliefs and Conceptions: A Synthesis of the Research” in Grouws, Douglas (Ed.) *Handbook of Research on Mathematics Teaching and Learning. A Project of the National Council of Teachers of Mathematics*, New York, Macmillan, pps 127 - 146.

Willis, Sue (1989) *Real Girls Don't do Maths. Gender and the Construction of Privilege*, Geelong, Australia, Deakin University Press.

Zeichner, Kenneth, Tabachnick, Robert and Densmore, Kathleen (1987) “Individual, Institutional and Cultural Influences on the Development of Teachers' Craft Knowledge” in Calderhead, James (Ed.) *Exploring Teachers' Thinking*, London, Cassell, pps 21 - 59.