EPISTEMIC TERRAINS AND EPISTEMIC RESPONSIBILITY

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> Mathematical education could…be interpreted as a method for stratifying students according to abilities that are established as socially important; at the same time, this method is conceived as objective, as it does not seem to incorporate personal sympathies and antipathies. (Skovsmose, 1993)

Skovsmose draws our attention to problematic aspects of the functions of mathematical knowledge. The social imperative, he suggests, governs those functions surreptitiously to the extent that any debate in or understandings of the place of the subjective in mathematics education is occluded. Objectivity is still the ideal, yet given the intersectional, multicultural, postcolonial identity claims of this era, questions of epistemology have become increasingly complex, demanding new conceptualisations of subjectivity and new analytical frameworks. In New Zealand, for example, as in many other Western nations, the 'subjective' has become a crucial aspect of positive resistance to various types of social thought. Attempts to demonstrate that knowing is produced at the exclusion of the subjective through some originary moment have run up against an outmoded theoretical edifice. Once one seriously entertains the prospect that mathematical knowledge, like all knowledge, might be merely a 'production', created and experienced by cognitive agents within social practices, the abstraction and objectivity of mathematical knowledge begins to look less than compelling.

In this paper I look at theories of cognition and the central epistemological preoccupation relating to those theories in mathematics education. First I look at the positivist-empiricist orientation of mathematical epistemology, centred on rational thought, as a means for individual and ultimately social empowerment. I draw attention to the principles of universality on which these theorises are derived, namely, that in the 'transfer' of knowledge, the conditions of knowing 'hold' for any knower, irrespective of history, identity, interests and circumstances. Secondly, I consider challenges to this central processing cognition model. I look particularly at the theory of situated cognition which subscribes to the view that cognition is produced in practices. Prompting an opposition to our conventional notion of pure abstraction and maintaining that mathematical truth is attained more by fiat than 'fact', this body of work endeavours to locate mathematical knowing in everyday activity. My aim is to open another "conceptual space" (Grosz, 2000, p. 28) for the discussion on knowers and the known.

Traditions of Mathematical Thought

Like all bodies of knowledge mathematics is premised on a set of claims to truth. Lessons learned from Foucault (1972) show how mathematics is caught up in 'regimes of truth', and that what comes to count as epistemology does not pre-exist certain normalising and regulating practices. In particular, modern 'enlightened' epistemologies based on positivist-empiricist principles, are defined around particular exclusions and inclusions: they are construed from the basic and implicit assumptions of a visionary metanarrative of moral and social progress. This vision relies on a commitment to the ideals of critical reason, individual freedom, and benevolent change. Granted this epistemological commitment has been exercised in a variety of ways but it has in modern times sustained the idea of progress through pure and untainted knowledge.

An articulation of these ideas had received a very clear expression in Déscartes' demand for the centrality of human reason. For Déscartes an engagement with rational thought would provide a firmer foundation for truth. This would be more useful than any other concept of human nature since to think rationally was to think in accordance with universal principles, independent of particular historical or cultural circumstances. Déscartes identified a mode of rational argumentation which articulated an essential distinction between mental and physical objects (in which the former is prior) as the sole route to the final cognitive product - unimpeachable knowledge. The certainty, control and predictability that it proffered guaranteed freedom from ignorance and rendered suspect the experiential, the phenomenal, the narrative and the supernatural as legitimate knowledge bases. In this form of logic he 'uncovered' "the natural order of things making possible the construction of technologies through which control might be exercised over the development of events" (Smart, 1993, p. 62).

Déscartes believed that this more objective rationally ordered and controllable society would evolve from mathematics. In his view mathematics was the hope for the world, the only reliable means for realising an 'enlightened' vision. Over the next few centuries this view came to be the view of others, underwriting all forms of social and intellectual life. It became naturalised, equated to thinking and hence fundamental to western democratic society. Indeed democratic social life, in both its structural and processual terms, and in all its various forms today, reveals an *a priori* commitment to mathematics. Concepts drawn directly from mathematical thought as created by Déscartes himself, and by Galileo, Newton, and Leibniz among others, are central to the way we map out, frame, create, model and articulate, for example, the techno-scientific theorised world of material process, and the business world of money circulation and its instrumentality (Rotman, 1993). Moreover, these concepts fold into and are constitutive of the very abstractions we form, providing metaphors, idealisations and perceptions for us to understand the many realities we inhabit.

The logic of rational argumentation took seed within educational theory and practice with the introduction and consolidation of simultaneous instruction and the modern classroom system. Initial modernist justifications for including mathematics in the formal school curriculum revolved around the idea that in developing mathematical reasoning in all people, society would be provided with a more secure rational foundation for attaining knowledge and making progressive change. Thus school mathematics became an objective historical force and it was through this means that the reasoning autonomous individual became central to Western political thought, politics and social organising. And it is easy to see how mathematics with its promise of inevitable progress in the task of human betterment became a prestige school subject, enjoying high social status. The implicit societal commitment to making the world a better place underwrites the intellectual endeavours of mathematics educators and legitimises their political and cultural role in providing formal mathematics classes for, in the estimation of Clements and Ellerton (1996), well over one billion people around the world.

Thus through a strategic practice of regulation of political imperative, mathematics came to be viewed as the means to Truth and Knowledge, and the desirable subject was produced. The unmasking of mathematical reason as intimately tied to the social organisation of power then becomes crucial to our understanding of 'who can know?'. Those who spoke in the name of mathematics came to possess a certain power. But not everyone was able to attain Truth. During those earlier times certain legitimating practices of social inequality rested upon the view that some individuals, and not others, could attain Truth through school mathematics, and could employ the right criteria – reason - in naming that Truth. Access to the kind of intellectual development which mathematics promised was seen as the exclusive preserve of certain males. Until recently extensive measures were taken, as Walkerdine (1988) has noted, to ensure that the mathematics of various 'others', on account of their 'nature', was excluded. Gender, race, ethnicity and a host of other determinations became a primary organiser of cognitive regulation. Scott (1996) has argued that invoking nature as the ultimate authority and drawing on 'common sense' arguments about 'differences' it was possible to argue the intellectual inferiority of those 'others'.

Clearly those 'others' do not belong to mathematics in history in the same manner as some males, on account of their 'nature'. However nature is a recent invention. Prior to the nineteenth century constitution of, for example, 'female' as a biological entity, girls and women were not considered subjects with distinct natural rather than god-given attributes. It was primarily the work of Darwin (Walkerdine, 1988) which created the female mind and body as a new object of scientific gaze and which led to the development of a doctrine legitimating what was able to count as 'female nature'. From that time it became possible to make 'true' statements about the nature of females, and also about blacks, the disabled, the economically disadvantaged, and so forth, precisely because in the social thought of the time science was considered the paradigm of a democratic public discourse. Science passed for truth, establishing 'difference' not only as a natural fact but also as an ontological basis for cognitive differentiation.

An epistemology which privileged the mathematical experiences of a particular group of people as paradigmatic for all mathematical knowers, sustained its hegemony until quite recently. Epistemic restrictions and paradoxes abounded yet were not addressed. On the one hand, mathematical knowledge production assumed an objective and value-free force, deemed over and above the circumstantial specificities and the socio-cultural locations of others. On the other hand the narrow context of the privileged mathematical experiences was held up as the experience of every knower. Feminists (e.g., Hekman, 1990; Irigaray, 1985, Kristeva, 1986) have been quick to draw attention to epistemological double standards and masked subjectivities. They note how rational thinking has been naturalised, through the legitimation of one perspective, arguing that "[t]hese subjects are invariably white, male adults who are propertied or at least professional" (Benhabib, 1987, p. 81). They challenge the characteristic orientation to thinking and the assumption that such modes of thinking, and the normative ideals of a small group, are common to all individuals and give access to a true reality.

New ideas do not emerge in any simplistic sense; rather they are closely connected to wider social imperatives. Interventionary measures in mathematics associated with wider practices of social inclusion (see Fennema, 1990; Forgasz, 1997; Leder, 1992), and the validation of the experiences of others previously associated with underclass status in mathematics (Becker, 1995; Boaler, 1997; Burton, 1995; Damarin, 1995; Ministry of Education, 1992) have remapped the epistemic terrain. Arguably these measures to some extent have set the parameters of what can be said and done with respect to school mathematics, and mathematics schooling has become a site embracing former marginalised modes of classroom participation. An epistemic space is opened for previously masked subjectivities, one which envelops rather than transcends particularity and locality. Lyotard's (1984) point concerning the importance of local narratives sits comfortably within this project.

Situated Knowing

Over the past couple of decades a number of mathematics educational theorists (e.g., Bishop, 1988; Carraher, 1988; D'Ambrosio, 1984; Lave, 1988; Nickson & Lerman, 1992; Restivo, 1992) have reworked knowledge production ideas towards models which emphasise the way in which knowers navigate their knowing through their own biographies and experiences. Arising in part from the wider social consciousness over issues to do with voice and representation their work challenges the narrow focus of mainstream cognition ideas to provide a more empowering approach to knowledge generation. Founded on a set of assumptions about unequal access to the production of knowledge, this body of work reveals a commitment to social change through the transformation of an unjust system. Though this commitment in mathematics education is inflected in a wide variety of projects it nevertheless reveals a desire to empower all individuals to develop mathematically and by this means to create a better communal life.

Burton (1995) questions the claim that mathematics is value-free, objective, dispassionate, and apolitical. I have noted elsewhere (Walshaw, 2001), her argument is that these ideals and the epistemology they inform, are the artefacts of a white, middle-class male community. She believes that theory which is inclusive of others is a more useful means for achieving knowledge of the world. The socially located and critically dialogical nature of the relocated epistemological project she envisages is guided by the concerns and interests of different others. Burton appeals to the powers of agency and subjectivity of learners who are disempowered through social determinations such as race, class, ethnicity, gender and classroom hierarchy. It is her contention that the mathematics of those groups, who have never emerged as 'speaking subjects' of mathematics but have always been spoken for or silenced by social and symbolic structures of exclusion, now becomes available. Learning takes place when those different knowledges are allowed to be voiced.

Lave's (1988; 1990) theory of knowledge production moves the epistemology question from a privileged subjective specificity towards the multiple character of social realities and knowledge. Challenging cognitivist psychology's central processor model of thinking, as well as mainstream theories of transfer, she provides an approach to the generation of knowledge which relies on context rather than abstraction. Laying bare the social and political contexts which circumscribe the production of mathematical knowledge, Lave's analysis argues for the constitutive role these contexts play in the creation and validation of mathematical knowledge. She subscribes to a social practice theory in which:

> Processes of learning and understanding are socially and culturally constituted…knowing, thinking and understanding are generated in practice, in situations whose specific characteristics are part of the practice as it unfolds. (Lave, 1990, pp. 18-19).

Lave's work, as it applies to mathematics education, calls for the transformation of our inward-looking reality of the learning process as depicted in apolitical epistemic posturings, through to a consciousness of the social situation and the activities in which knowing occurs. Based on her studies of apprenticeship tailors in West Africa, shopping and other everyday practices, Lave's argument proceeds from the presupposition that mathematical competence is situated and intrinsically shaped by the social situations and the activities in which learning occurs. Her situated learning theory links the contextual with the historical, insisting that a whole set of rich and diverse factors – past, current, and yet ever-changing – interrelate in order to constitute the forms and direction which mathematical competence might take. Cognition for her is dialectical and multi-levelled, within which history, tradition and culture are the bases for truth. This idea stands up against what we have come to know from classic mathematical models about knowledge, as the acquisition by detached and faceless cognitive agency, of decontextualised constructs, abstracted from the concrete, and dislocated from the means of production. Moreover it confronts our mainstream ideas about 'knowledge transference' as exacting its application within multiple situations.

In opposition to ideas which blur vast differences within the learning experience, situated practice theory asserts the socio-political investedness of knowledge-production activity. Insisting on the variability of the experiences and practices of cognitive agents from which knowledge is constructed, Lave claims that knowledge then is derived out of the specific human interests of cognitive agents, and is more relational than transferred, caught up in the ongoing connections between people, settings, and activities. If mathematical learning is to be understood through a network of relations between people and settings, then conceptual knowledge, activity, culture and social relations become interdependent. The theory calls for an acceptance of the production of mathematical knowledge or mathematical problem solving as structured activity defined by the learning practices themselves, always interwoven with socio-cultural necessities and meanings. Mathematical solutions are, hence, merely resolutions, and may be further transformed in the future. For Greeno (1998) and others who employ this analytic framework, the interest is in how a community of learners constructs personally and socially viable theories of the ways in which the mathematical world works.

Reorienting questions about knowledge from absolute foundations to positions within the social practices of knowers, does enable us to unlease the bonds of objectivist detachment. It provides a response to the problem of transparency of mathematical 'facts' and the instrumental rationality it presupposes. It seems to deal with the problem of those knowers whose subjectivity is effaced within the formulations of traditional theory. In a discipline which depends for its credibility upon knowing people, a model like Lave's, which is organised around the variable constructions of mathematical reality, has to be a significant advance on historical precedent. And a position which takes into account the knower's subjectivity in the engagement of cognitive practices – his or her interests, emotional involvement and investment, assumptions, material, and historical and cultural circumstances - must be instructive in debates surrounding epistemology questions.

However is the proposal suggestive of relativism? It is true that Lave's proposal avoids modernity's mistake of claiming "everywhere while pretending to be nowhere" (Code, 1993, p. 39). Yet does the theory make claims to be nowhere and everywhere simultaneously? If definitive assessments of knowledge claims cannot be forthcoming, how will credibility be established? That question takes us into another realm – the realm of authority and power structures of mathematics education communities. Upon what agendas do we base our judgments? Whose values and ideals tend to prevail? These questions are posed here in order to draw attention to the difficult and sensitive issue of *epistemic responsibility*: to ensure that we guard our practice from contamination, to ensure that we keep ourselves on our "cognitive toes" (Code, 1993, p. 37), and above all, to ensure that we keep the debate going.

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