Uniting Psychological, Sociocultural and Poststructural Axes of Analysis to Better Understand Learning in Mathematics

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Psychological views of learning have long informed mathematics and numeracy education. Such views support reasoning processes as foundational to the construction of knowledge and its application. In this cognitive sense the learning process is productive, though it can also be productive in the construction of identity (the learner's sense of self as a legitimate participant in numerate practices). A poststructural axis of analysis recognises the power relationships in all teaching interactions, and the learner's constitution as active numerate participant with/in them.

Learning experiences in new times should be qualitatively different from those of previous times. Today, beyond the construction of knowledge and skills, learning experiences should fuel or cultivate the flexible and responsible application of mathematical ideas in a difficult and chaotic world; application should not be taken for granted. "Numeracy", according to Ministerial Council on Education, Employment, Training and Youth Affairs ((MCEETYA) (1997, p. 130) "is the effective use of mathematics to meet the general demands of life at school and at home, in paid work, and for participation in community or civic life". While the learning process has always been considered important in relation to the construction of mathematical knowledge, knowledge unconsciously constructed can influence the appreciation of, engagement with and application of mathematical ideas. As Walshaw (2004, p. 126) claims, although the emotive and unconscious aspects of learning "are deemed intrusions or irrelevancies within pedagogical encounters", they can have an enormous, though invisible, effect on participation and future practice.

Educators however, have difficulty in overriding the overly simplistic view of the learning process reproduced in policy and the media. Learning to recognise oneself as numerate is a complex process, though stakeholders tend to grab on to one element of this process and hold it up as *the* answer to current problems. Arguments are put in commonsense terms, making disagreement difficult, though any proposed rectification merely touches the surface, if mentioned at all. For example, the content, robust disciplinary knowledge has long been thought to be the only key, ignoring how the learning experience itself can be alienating in suppressing engagement and idiosyncratic sense making. As students participate in learning mathematics, many of them sense that it is just too unsatisfying and not for them. This sensing is unconscious though powerful; it is constitutive and influences participation now and in later life. As Lather (1991) makes clear, in one's action (as numerate being) is one's constituted *knowing* about participation as satisfying, compelling, or not.

The argument I make in this paper is that a deeper and more comprehensive understanding and theorisation of the learning process is needed to arrest the tide of students leaving school with such a 'bad taste in their mouths' regarding mathematics. This should begin at the level of the individual learner, and look to those elements of the environment that speak positively to the mind and the emotions: where are the opportunities for thinking and reasoning, for collaborative inquiry and communication of ideas, for establishing *ownership* of mathematical relationships, language and application? And…where are the opportunities for the learner to *be* numerate, to recognise oneself and

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be recognised as a legitimate participant in the construction and application of mathematical ideas, able to explore, investigate, wander outside the box and find affirmation for this wandering? Each aspect of learning, the mathematics and the construction of self as numerate, is crucial yet indivisible from the other; discursive strategies which fertilise both potentially constitute an energising learning environment that mobilises thought and the application of mathematical ideas.

Crossing Philosophical Divides

In relation to numeracy education the three philosophical positions, differing on the nature of the relationship between the individual learner and the learning process, could be seen to form concentric circles with the psychological at the core, surrounded by the sociocultural, enveloped and underlined by the poststructural. Moving from the core outwards, the learning process assumes the responsibility for *shaping* learning to *constituting* learning (Walshaw, 2004). Views of learning in the outer circle are sensitive to power relations in all discursive practices, and how they uplift and enliven (or not) participation.

This difference in philosophical orientation is crucial to my argument in this paper; mathematics is a discipline, it is a science of pattern and order. Psychological and sociocultural epistemologies well inform the construction of powerful ideas central to mathematical proficiency (National Research Council, 2001). Mathematics is at the very core of numeracy, a state of being numerate, though the *being* or *becoming* numerate is assumed rather than carefully theorised in psychological and sociocultural views of the learning process. A poststructuralist view of learning adds complexity, for it does not take for granted a rational and cognate being capable of translating constructed knowledge directly into practice. Poststructuralism asserts that what we have are individuals whose learning process is overwritten, nuanced by inclusions and exclusions in the learning context (which is vast, extending to all the discursive practices through which their identities have been formed). In some ways the poststructuralist version of the individual is disconcerting, while in others it forces us to accept that states of being numerate are constituted in teaching strategies and practices, and that if we hope to improve students' perceptions of mathematics and their facility in using its powerful ideas, then more supportive pedagogical relationships are needed.

Building Cognitive Structures

At the core of the concentric circles and foundational to establishing oneself as numerate is a solid understanding and appreciation of mathematics. Learners should develop and be able to draw upon a rich web of interrelated concepts and skills, strategic thinking processes and skills to develop a critical understanding and appreciation of the usefulness and logical nature of mathematics (Queensland School Curriculum Council, 2001). Psychological and sociocultural epistemologies have fruitfully informed research in this area, where learning is seen to happen inside the individual, an intra-mental process of developing internal structural representations (Goldin & Shteingold, 2001). Here the mind is central, and fruitful learning is seen to be a matter of internal self-organisation. Moving out from the centre of the concentric circles, though, it is recognised that an individual learner can not be fully segregated from the social context. Rogoff (1998, p. 687), for example, says "individual, interpersonal and cultural processes are not independent entities". A sociocultural axis of analysis focuses on how cultural practices, such as doing

mathematics, are learned as novices are enculturated into those practices: "Talking about mathematics becomes acceptable, indeed essential, in the classroom, and mathematical discussion, explanation, and defence of ideas become defining features of a quality mathematical experience" (Walshaw & Anthony, 2008. p. 516).

Growing Participation

Over time, *better* learning in mathematics has come to be associated with higher levels of active learner participation in collaborative tasks, such as mathematical investigations and problem solving. Improving learning is sometimes equated with increasing participation (Lave & Wenger, 1991) as "an integral part of generative social practice in the lived-in world" (p. 35). Moving out in the philosophical circle, though, questions arise as to the qualitative dimensions of this participation, and how exactly it becomes generative. How can talking about mathematical ideas – representation, discussion, explanation, justification – lead to numerate action? While potentially robust mathematical constructions are made, how does this ensure their expression and application in the world beyond school? Can we allow thinking and reasoning to become the "core and target" (Valero, 2004; p. 39) of numeracy education? Should we rest comfortably with psychological and sociocultural views of learning where, as Walshaw and Anthony (2008, p. 540) state: "The most productive discourse is that which allows students to access important mathematical concepts and relationships, to investigate mathematical structure, and to use techniques and notations appropriately".

The answer to these questions depends on how one sees the learner and the influence of the learning environment or context; for psychological and sociocultural views of learning the learner is a rational, cognitive being linked to, though separate from, the learning context. Here it can be assumed that cognitive structures can and will be used in application where necessary, as they have been arrived at through "productive discourse" as explained by Walshaw and Anthony (2008), above. However, as we move outwards in the concentric circles, the learning environment becomes more invasive, it washes over the discourse and practices of the classroom and becomes productive in that it is constitutive. Suddenly it matters that the learner is positioned as an "active epistemic agent" (Walshaw and Anthony, 2008, p. 535) since this positioning enhances learning and causes the learner to sense legitimacy as a doer and user of mathematical ideas. Positioning has to do with the operation of power relationships; it has to do with learners having a real *presence* in classroom discourse, being able to initiate and follow through discourse threads, being encouraged to find learning relevant by applying personal understandings to classroom tasks. *Positioning* is about using power relations in a positive way to support the construction of knowledge and a sense of self as a legitimate participant in the becoming numerate discourse. As Butler (1997, p. 2) says: "If, following Foucault, we understand power as forming the subject as well as providing the very condition of its existence and the trajectory of its desire, then power is not simply what we oppose but also, in a strong sense, what we depend on for our existence and what we harbor and preserve in the beings that we are".

Attaining and Maintaining Legitimacy

A poststructuralist analysis of teaching mathematics for numeracy concentrates on the *quality* of participation afforded each student rather than the amount. Poststructuralism displaces the rational humanist learner of positivist thought, positing instead one who is

buffeted and/or aided in establishing oneself as a legitimate active participant in a discourse or intersecting discourses (such as those of mathematics and education). Whatever the discursive practices in education, it is important in this postmodern era that strategies are chosen that support creative and original thinking, flexibility of thought and confident justification of ideas. Being numerate is not just about content, it is not just about thinking and reasoning; it is these things, but more. Being numerate is an extended exploration or journey, it is founded on the mathematics and the communication and application of mathematical ideas; it is also founded on and framed by the constituted sense that one can, and should and will use mathematical ideas flexibly and wisely in life and work after school.

Conclusion

Alongside, and complementary to, well established psychological and sociocultural understandings of the learning process as "shaping" learning (Walshaw, 2004), a poststructuralist lens posits the learning process as constitutive; that is, power relations in how it operates influence the extent to which learners are able to recognise themselves as capable and engaged participants in the discipline or discourse. As Johanna Oksala (2007, p. 15) states: "The subject is not an autonomous and transparent source of knowledge, but is constructed in networks of social practices which always incorporate power relations and exclusions". Although students attribute their lack of disciplinary knowledge and dislike of mathematics to personal characteristics (a psychological or humanist reading), this could be reinterpreted as the inability of past discourses to ensure their full and legitimate participation as numerate individuals (a poststructuralist reading recognising social, linguistic, unconscious relations of power).

In conclusion, a cautionary word from Foucault (cited in Valero, 2004, p. 49) in relation to the complexity involved in becoming numerate: "Power" he says, does not come from the "possession" of knowledge alone, but from "the manifestation of a relation in which people position themselves in order to influence the outcomes of a situation using diverse tools". While psychological and sociocultural constructs of learning provide the "diverse tools", they are liable to remain unused in the toolbox if their owner lacks the constituted sense that s/he can capably act to influence outcomes. Lather (1991) referred to this constituted knowledge as *knowing*, a space beyond the rational and conscious where heart, mind, body and soul come together as one to influence practice, in this case the learning and application of mathematical ideas in a global, changing world.

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