SOCIO-CONSTRUCTIVISM AND TEACHERS' MATHEMATICAL EDUCATION: TOWARDS AN ALTERNATIVE DISCOURSE.

The discourse of the mathematics classroom transmits messages not only about what it means to know mathematics but also about how mathematics is learned. Recent developments in cognitive psychology and mathematics education depict learning as assimilation of novel experiences towards personal and social construction of meaning in mathematics. In this article I propose that classroom discourse, if it is to be empowering for students, should reflect this socio-constructivist view of learning as a process of coming to know rather than as the remembering or recall of facts and procedures. Embedded within each discourse are fundamental notions of power and authority in depicting whose knowledge is valued and who has the authority to speak with status. It seems incumbent upon the university educator to model teaching as the facilitation of a process of coming to know through a discourse of inquiry if teachers in pre-service educational institutions are to experience and critique the alternative discourse.

INTRODUCTION

Boomer (1992) relates the thought that curriculum guidelines generally adopt a constructivist view of the nature of learning and extol the virtues of interactive classrooms and a problem-solving inquiry approach to teaching. But he makes the point that because of factors such as the entrenched structures of schooling, attitudes and valuing systems, there is little relationship between stipulations made in these documents and what actually takes form in classrooms. Boomer (1992, p. 62) states:

We speak constructivism but, to a large extent, enact behaviourism. We understand the value of enquiry and problem solving, but we find ourselves transmitting knowledge and requiring recitation.

No-where is this more true than in the teaching of mathematics where there has been little change from routines of the past depicting mathematics as an ahistorical, "natural" and immutable body of knowledge to be transmitted to students (NCTM, 1989;
Weiss, 1989). Popkewitz too (1988, p. 245) comments on the difficulty of bringing about change in the mathematics classroom as present practice has a history of teacher behaviour patterns, cultural norms of the classroom and school organisation; discursive practices not readily amenable to change. Add to this social conditions outside the school and the discourse of school mathematics is seen as enacting moral and political discipline expressed as follows by Popkewitz (1988: p. 226):

We can begin to understand from the urban elementary school mathematics lesson that the form and content of schooling are interrelated; they not only channel thought and action, but posit social values about authority and control.

The view of mathematics held by many undergraduates as they enter coursework in mathematics education in the tertiary institution is that which has become constitutive of them over twelve or so years of mathematics in school. I take the comments of one such student to examine how this particular student has been constituted by the discourse of mathematics during her schooling years. From Foucault I adopt the notion that to redress this position it is necessary to detach the power of truth from social, cultural and political hegemonic notions of truth. Foucault states: "The problem is not changing people's consciousness - or what's in their heads - but the political, economic, institutional regime of the production of truth" (cited in Gordon, 1988). To this end I attempt a portrayal of a discourse representative of constructivist assumptions concerning the teaching and learning of mathematics and conclude with a concern that the result is not merely a shift in discursive technology.

TRUTH CLAIMS OF MATHEMATICAL DISCOURSE CONSTRUCT THE SUBJECT.

Foucault's (1974, p. 49) definition of discourses are that they are "practices that systematically form the objects of which they speak...Discourses are not objects; they do not identify objects, they constitute them and in the practice of doing so conceal their own
invention". Useful here too is his notion of power/knowledge; an inseparable configuration of practices and ideas constituting a discourse. "Knowledge" says Ball (1990, p. 5) "does not reflect power relations but is immanent in them".

Bourdieu and Passeron (1990, pp. 108-109) stress the role the traditional pedagogic institution has in endowing agents with status authority which tends to rule out completely questions of the usefulness of information transmitted. The authority of the pedagogic institution defines who has authority to speak, about what and to whom. Bourdieu and Passeron (1990) depict students as willing to tolerate "semantic fog" exacerbated by the "particularities of the space" by means of which the professor is suitably distanced from the audience who do not enter into the dialogue (p. 109). Such a discourse tends to overly constrain the possibility of student thought.

A student in my mathematics education course relates past experiences:

My memories of maths at primary school are voids of non-comprehension......Tables were a big thing - learning them off by heart for homework then regurgitating them loudly in class. Volume was a mystery, and I have always avoided having to use it - estimating instead.

I must have been away the day we learnt about decimals, because I never quite caught up, and percentage was never quite within my grasp, unless it was something easy, like 25% or 60%. I've never known how to convert a fraction to a percentage, although I remember "hearing" it at school.

High school maths consisted of opening a book and working from one end to the other. I shared my book, chatted the year away, and failed. Consequently, I dropped maths as soon as possible, to my delight and never went near anything vaguely mathematical again. I distinctly remember learning "theorems" in geometry, whatever they were. The teacher seemed only to be interested in those who would obviously excel in the subject, and too happy to let the others drop out - the sooner the better.

Although I did "basic" maths at high school, it always seemed too hard, beyond me, meaningless. It certainly did not empower me, except to add, subtract, multiply and divide (with a pencil and paper, or calculator).

The discourse, including discursive practices, of the classroom embedded
with notions of authority, legitimacy and power became constitutive of a student who came to view mathematical knowledge as information to be transmitted, a commodity to be obtained - "I must have been away the day we learnt about decimals". Her identity, her subjectivity was formed and she saw herself as defective in some way - "I never quite caught up" and "percentage was never quite within my grasp" inflicting upon herself a "technology of the self" (Foucault, 1988, p. 18). A "technology of power" (Foucault, 1988, p. 18) afforded her no status or agency within the group - "High school maths consisted of opening a book and working from one end to the other". Even more worrying is the acceptance of a discourse which equates "learning" with not knowing - "I distinctly remember learning "theorems" in geometry, whatever they were.

Underlying the discourse and discursive practices of the behaviourist classroom is the hegemonic notion that the learning of mathematics is a necessary "good" for all even though there will be many not able to fathom its depths. Herein too, is the hegemonic affirmation of the scientific/technological base of societal structures where "subjects become objects, power is hidden in a maze of numbers, and purpose is seen as irrelevant to the constructions of social life" (Popkewitz, 1988, p. 234). Alternatively learning based on socio-constructivist principles may address many of the causes of loss of agency experienced by students with stress on a discourse of inquiry which must recognise knowledge acquisition as a process of "coming to know" in a social and political context. As an alternative discourse it must take account of the dialogical nature of the processes and content necessary for reflective knowledge development in the socio-constructivist mode.

A SOCIO-CONSTRUCTIVIST VIEW OF KNOWLEDGE CONSTRUCTION: COMING TO KNOW AS SOCIAL PRACTICE.

von Glasersfeld (1989, p. 162) depicts the two basic tenets of constructivism thus:

Knowledge is not passively received but actively built up by the cognising
subject, and

The function of cognition is adaptive and serves the organisation of the experiential world, not the discovery of ontological reality.

Essentially, mathematical knowledge is a mental structure, actively constructed and evolving, rather than a formula, fact or procedure transmitted to be remembered. Structures are built up through reflection on experience relative to present mental structures, through assimilation, accommodation, and reflective abstraction (cf Piaget, 1972). What students learn is not simply some part of what they have been told but rather new information gained through experience causes dis-equilibrium in present mental structures ("perturbation") which may potentially result in accommodation, hence learning. As such, each student's knowledge is a uniquely personal construction, though socially constructed.

It is important to acknowledge both the physical and social reality that is a person's experiential world. Knowledge seen as a personal construction cannot be other than a social construction as well, as each individual is constituted by particular social and discursive practices, including power relations. Socio-constructivism sees reality as a construction through language and goes beyond a purely Piagetian view of the role of language (as merely one of the manifestations of the symbolic function) to consider language and the social domain primary influences on the construction of mathematical (and socio-political) knowledge.

The teaching of mathematics in the socio-constructivist tradition would move away from the influence of the structuralists and the use of pre-structured, ready made materials to a process of "mathematisation", towards the development of a mathematical literacy which I perceive as the ability to formulate, criticise and develop understanding in mathematics through investigation and inquiry. Students in this way are stimulated to learn for themselves through being able to make sense of mathematical experiences. If students are to
take more
responsibility for learning, important features of the socio-constructivist
approach must
include investigation of mathematical topics of relevance, not pre-
specified and fixed as
would be found in a text book or work sheet, and decisions to be made
should include
negotiation between the teacher and student.

The National Research Council (1989, pp. 58-59) summarises future
possibilities for
discourse and discursive practices of mathematics classrooms. The council
states:

Effective teachers are those who can stimulate students to learn
mathematics.
Educational research offers compelling evidence that students learn
mathematics well only when they construct their own mathematical
understanding. To understand what they learn, they must enact for
themselves
verbs that permeate the mathematics curriculum: "examine", "represent",
"transform", "solve", "apply", "prove", "communicate". This happens most
readily when students work in groups, engage in discussion, make
presentations, and in other ways take charge of their own learning.

So that students have a more active part in the construction of meaning,
socio-constructivist
practice would necessitate changes to classroom discourse and discursive
practices giving
students more control over the formation of the educational process. This
is essential if
students are not to become constituted by meaningless rituals of the
mathematics classroom.
Similarly, pre-service teacher educators concerned that students will later
teach this way
might re-examine present practice and themselves attempt to instigate a
discourse with the
potential for student teacher empowerment through enabling them to "make
sense" of
mathematical experiences, with implications for the later teaching of maths
made explicit,
for student consideration and critique.

SOCIO-CONSTRUCTIVISM, DISCOURSE AND DISCURSIVE PRACTICE.

Some of the changes necessitated by a view of knowledge as a process of
"coming to know"
in a social and political environment would necessitate a view of the
mathematics classroom
as a community of learners, rather than a mere collection of disparate
individuals thrown
together by fate, obliged to receive a message. All students would be
recognised as having
something to offer the mathematical community and the teacher would no
longer be the sole
126) put it thus:

Through dialogue, the teacher-of-the-students and the students-of-the-
teacher
cease to exist and a new term emerges: teacher-student with students-
teachers. The teacher is no longer merely the-one-who-teaches, but one who
is himself (sic) taught in dialogue with students, who in their turn while
being
taught also teach. They become jointly responsible for a process in which all
grow.

There would be a movement away from mechanistic answer-finding and
memorising rules
and formulae to group negotiation of meaning. Mathematics would more often
be applied
to problems facing the students and the community, and its uses and misuses
therein
critiqued. Textbooks and worksheets would find limited application in a
classroom/lecturehall dedicated to social construction of meaning.

In the tertiary context discussion of mathematics, and how mathematics
should be taught,
both social constructions, would necessarily include critique of issues of
social justice and
power. Is it likely that a change from the "banking concept" of the
acquisition of
mathematical knowledge and its concomitant discourse, to a discourse of
inquiry where
knowledge is viewed as a social construction and tentative, will prove
"empowering" for
children in school and pre-service teachers as well? Is it possible that
hegemonic notions
previously constructed of the teaching and learning of mathematics can be
re-learned or re-
constructed through participation in a discourse of inquiry? A discourse
of inquiry is
suggested as that which may facilitate mathematisation where learning is a
process of actively
coming to know a body of socially constructed mathematical "truths" through
investigation
of everyday problems.
TEACHER EDUCATION AND A DISCOURSE OF INQUIRY.

If we are to model teaching behaviour representative of a view of learning as a process of coming to know, our teaching actions can no longer be seen as technical behaviour with guaranteed outcomes. Grundy (1992) makes the point that what is sorely needed is the development of a new discourse which takes into account the unpredictability of social, and hence educational practice. Grundy (1992, p. 158) states:

Far from being apologetic about our inability to give guarantees about the outcomes of schooling, we need to develop a new discourse of possibility in which human action with all its uncertainty is celebrated.

The discourse of a mathematics as coming to know is a discourse of possibility, it is a discourse of wondering, a discourse of inquiry. Knowledge formed is tentative and evolving, never static, never finished, not easily measured and quantified. The difficulty is the translation from a discourse of poiesis to one of praxis in mathematics education in our schools and universities. Grundy (1992, p. 163) describes the discourse of poiesis as the discourse which objectified the student teacher quoted earlier in the educational process with efficiency as the hegemonic value and effectiveness a measurable commodity. However, she does not see the social world as one to be acted upon, rather as a world to be acted within.

Praxis is the form of action characteristic of interaction, action in the social world (Grundy, 1992, p. 162).

The dialogical nature of socio-constructivism equates learning with a change in mental structures through assimilation, perturbation and eventual accommodation through reflective abstraction. Changing students' concepts of (students' learning about) what constitutes a mathematics education for the twenty-first century, and how it might be realised, will only be found in changing, and making explicit, the discourse attending the teaching of mathematics in the socio-constructivist tradition. But Gee (1990, p. 153) points out that it is almost impossible to critique a discourse from within it. There is a
possibility for change
though from his statement: "...we can only talk about a literacy as being 'liberating' ('powerful') if it can be used as a 'meta-language'...for the critique of other literacies and the way they constitute us as persons and situate us in society".

As student teachers are involved in learning mathematics through active involvement in a socio-political environment they must be enabled to re-construct views of how mathematics is learned and so taught by critique of competing discourses. It would no doubt prove useful to critique and contrast behaviourist, structuralist and constructivist discourses in mathematics over the past fifty years and in each case make explicit aspects of the various uses of mathematics. Who uses it? In what situations? Whose knowledge-constitutive interests are advanced by the subject matter studied? What should pupils in school be given the opportunity to learn under the guise of mathematics? How does the discourse of various schools of thought in mathematics education contrast with that in other disciplines taught in schools?

Socio-constructivism forces upon us a post-structuralist attitude in our teaching practice (see Grundy cited earlier). There will always be uncertainties, ambiguities, criticism and questions - that is attendant upon the nature of the task we undertake. But surely there is also the opportunity for us and our students through a discourse of critique and inquiry to understand ourselves more fully, why we are what we are and why we believe and act as we do? Cherryholmes (1988, p. 149) believes that an increased level of understanding will result in increased freedom from existing social structures and "more power to create our societies and schools rather than the other way around".

It is necessary that we initiate the process of coming to know the post-structural era in our students so that they may be assisted in relinquishing myths of certainty with regard to the development of mathematical knowledge and how it should be taught. After
all, states Ernest
(1990, p. xi) this in indeed "the next act of decentration that human
development requires".
The discourse of socio-constructivism, to the extent that it can be
realised in tertiary
institutions, should be employed as a meta-discourse from which to critique
all discourses
and "to criticise the working of institutions which appear to be both
neutral and independent;
violence which has always exercised itself obscurely through them will be
unmasked, so that
we can fight fear" (Foucault, 1974, p. 171).

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