THE CONSTRUCTION OF SPATIAL MEANING AND SOCIAL DISADVANTAGE

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One of the biggest problems facing mathematics educators is the non-random failure of minority groups in mathematics. Two major discourses address this problem, psychological discourses which focus attention on the individual, and sociological discourses which focus at the socio-political level of analysis. They are essentially disjoint sets which offer different explanations for the phenomenon but can not adequately account for each other. These dominant discourses which prevail in mathematics education are discussed along with their respective limitations in understanding the meanings that children construct in the mathematics classroom and the construction of social disadvantage. For the purposes of this discussion I will focus on two major discourses that operate in mathematics education. The first is that which I refer to as the psychological discourses, and perhaps the more dominant in the field. The primary focus within this field is on the individual construction of meaning. Of particular concern is the intersecting discourses of developmental and cognitive psychology. In contrast the second discourse which I refer to as sociological, is that which focuses on the wider social structures and how these impact upon mathematics education. This latter field is often critical of the role that mathematics education plays in society, and runs the risk of being rejected by many "conservative" mathematics educators.

Through this paper, I hope to challenge these research discourses and suggest that it may be more appropriate to examine the practices which constitute the outcomes that enable such discourses to be constructed. What I am proposing is a research discourse that will enable the examination of the social construction of meaning, both at the level of the individual and the social, to examine the mutual constitution of these factors in the construction of meaning and social disadvantage in the mathematics classroom. The proposed research will be attempting to look at the practices in schools that legitimate success in mathematics. The perspective that will be taken in this research will be that failure in primary school mathematics is essentially a product of the practices that have been institutionalised through schools.

PSYCHOLOGICAL DISCOURSES

Perhaps the most influential writings in epistemology are those of Piaget, or those which have been influenced by his writings, such as the van Hieles' theory of geometric thought. While recognising the flaws in much of his work, Piagetian based theories have had a major and powerful impact on the conceptualisation of education and the child. Of particular relevance is the adaptation of his work in geometric thought as apparent in the van Hieles' theory.

Psychological discourses focus attention on the individual construction of meaning and then attempt to develop theories about the perceived consistency in the progression of mathematical cognition. Such theories have had an immense impact on the way in which child development is constructed within the Western world, so much so it is often difficult to perceive as otherwise. The notion that children go through certain characteristic phases in their progression towards adulthood is firmly entrenched in our world view and hence in the language we use to describe children. Foucault has adopted the term ***regimes of truth*** to refer to the wide acceptance of phenomena within a society so that they are seen to be truths for those people. Yet, perhaps this is all they are, socially constructed phenomena that have become reified within the society so as to constitute a reality for that group of people.

These theories have permeated the curriculum in such a way that it is difficult to decipher what is seen to be reality and that which is socially constructed. For example, in the infant areas of school, it almost goes without saying, that children need to use concrete materials if they are to come to understand number and operations. Similarly, the transition from primary school to high school for Australian children, coincides with the (supposed) emergence of formal or abstract thought. The notion that children of this age are able, or at least expected to be able to perform abstract reasoning is reflected in the changes in the curriculum whereby children in Year 7 are introduced formally to Algebra, a subject which can be seen to symbolise abstract thought. Yet, I would ask is it the case that the curriculum has been organised in such a way as to coincide with these critical periods in the development of cognition, or is it the case that these environments give way to the development of these stages of cognition? Consider van Hieles' model of geometric thought. Is the progression through the levels an almost natural process, or is the environment organised in such a way that encourages geometric thought to progress in the way that is suggested by the theory. The dominance of such theories on child development, and their verification in the everyday lived experiences makes it difficult to imagine that it could be anything but natural, yet there seem to be a number of incongruencies that should make us at least sceptical. These include cross cultural analysis, along with historical analysis of childhood, schools and the curriculum.

One of the major problems with such theories is their cultural bias. Gay and Cole's (1967) study with the Kpelle people of Liberia indicated that abstract thought was not a "natural" part of their repertoire of cognition, yet when inserted into the school context they were able to learn this skill. This indicates that this type of cognition may be a product of schooling. Similar studies with the Central Australian Aborigines (such as Seagrim and Lendon, 1980) reported that these people were "lacking" in what would seem to be basic cognitive skills according to Piagetian-type theories. Such cultural deficit models have been challenged and their inherent flaws exposed.

While we have gone some way from Seagrim and Lendon's proposition in the 1970s in the recognition of cultural diversity, the search for universals or grand theories, effectively denies the uniqueness of cultural differences and the inherent politics contained within such theories. Such theories fail to account for the cultural bias that is contained within the theory. The manner in which Western society organises and classifies information is often different to that of other cultures, yet this is not acknowledged in these theories. For example, in many Aboriginal cultures, there is no need to differentiate shapes (refer Harris 1987, 1991). Such cultures have a limited language insofar as shape is concerned, and as such, the highly technical way in which shapes are discussed in Western cultures is incongruent with these cultures. It would be reasonable to expect that these people would not do as well on spatial tasks as Westerners. It is not because they were functioning at a different level *per se*, but rather because the task was totally inappropriate to the culture. It is not a matter of *cognitive* difference, but rather one of *cultural* differences.

Historical analyses of childhood, (see Aries,1973; Walkerdine, 1988) indicate that the notion of childhood is a relatively recent phenomenon in the history of humankind. The notion of childhood seems to emerge after the Dark Ages. Children were not expected to be self sufficient at a young age. This period of dependence upon parents may be seen to be the catalyst for the emergence of childhood as a unique phenomenon.

The inherent "naturalness" of child development that is contained within grand theories, denies the social and historical conditions that brought about their construction. By examining these conditions, it becomes apparent that they perhaps are not so natural, but are contrived. Walkerdine (1984, p. 164) argues that "it is developmental psychology itself which produces the particular form of naturalized development of capacities as its object."

When there is an assumed naturalness abut child development, then those children, or more importantly, those groups of children, who fail to be successful in constructing their mathematical concepts are seen to be functioning at lower levels of cognition. Within the more traditional modes of pedagogy, the role of the mathematics teacher is to somehow bring about change within the individual in order that a higher level of cognition is brought about. The function of mathematics is not called into question, almost as though it is politically and historically neutral. Thus the nonrandom failure of socially marginalised groups in mathematics is more likely to be interpreted as a lower level of individual cognition, rather than being seen in the context of wider social, cultural and political factors.

SOCIOLOGICAL DISCOURSES

The growth of the sociology of education in the 1970s called into question the role of schools in maintaining the social order. Insofar as mathematics education is concerned one of the main emphases would be on understanding why working class kids end up in working class jobs and the role that mathematics has in that process. Bowles and Gintis' (1976) correspondence theory built on Marx's thesis that inequality was a fundamental and integral part of capitalist society. The role of schools was seen to be to prepare children of the elite social groups for their elevated status on the social hierarchy by positioning them in situations that encouraged certain characteristics affiliated with this higher status to be nurtured. In contrast, children from the lower echelons of the social order were trained to accept their lower places in the social hierarchy through a process that encouraged docility and conformity, as well as the acquisition of skills that prepared them for manual labour (Mehan, 1992). Such theories have been strongly criticised for being overly deterministic (Cole, 1988, Apple, 1983). They also fail to take into account the practices in schools which produce inequality. It also ignores the potential of the individual effectively rendering them to passive pawns of capitalist goals. In contrast, Bourdieu and Passeron (1977a, 1977b) proposed that through what they refer to as "cultural capital", members of the social classes inherit substantially different elements of the culture than peers of a different social class. Success in schools is thus a matter of appropriating the culture of the dominant groups, which is, conveniently for the dominant groups, also that of the schools. Thus for Bourdieu and Passeron, schools are seen to reproduce social inequality by valuing and rewarding the culture of the dominant groups. Bernstein (1974) also posited a similar position with his notion of linguistic codes, whereby the code of the middle class was *elaborated* and the working class was *restricted*. While his theory was used to justify the failure of working class children because they did not have an appropriate linguistic form, Bernstein's proposal suggested that there was a cultural incongruity between that of the schools which used and valued the elaborated code, and the working class children's restricted code.

Apple (1983) and Giroux (1983) have criticised Bourdieu's explanation on the grounds that it fails to recognise the human potential in breaking the process of reproduction. Instead, such critics argue that Bourdieu and Passeron appear to treat students as passive recipients of cultural capital. From a sociological perspective, working class children frequently do not succeed in mathematics not because they function at various levels of cognition, but rather that the culture that mathematics represents is incongruent with their own. Bourdieu (1977) uses the notion of *symbolic violence* to signify the insertion of the working class student into the culture of the dominant group. As d'Ambrosio (1985, 1990), Chevellard, (1990) Dowling (1992) and Joseph (1987) have argued persuasively, the mathematics of schools is a unique cultural representation. Sociological discourses questioned the political and cultural biases in mathematics education, challenging the notion that mathematics is culture and value free. As a consequence, mathematics can be seen to be a product of the society in which it is located and hence is influenced and shaped by the particular values and beliefs that are held by that society. Mathematics as it is taught in schools, is a Western construct and is seen to favour the middle and upper class culture within that society. Thus to be seen to be successful in mathematics, is not a function of conceptual understanding *per se* as would be the primary focus in psychological discourses, but equally a matter of cultural congruence.

The role of mathematics in the process of social and cultural reproduction is seen to be paramount. Chandler Davis of the mathematics department at Toronto University wrote that "The main function of mathematics in advanced capitalist society is the maintenance of social stratification" (cited in Webber, 1987). This point is also reiterated by others such as Clements (1989), and Barnes (1987). After all, it is readily recognised that the key to the most powerful and prestigious professions in our society is achieved through the study of school mathematics, regardless of how relevant it may be to the respective profession. Yet what most students learn through their insertion into school mathematics is that they can't do it (Clements, 1989, Pimm, 1991). In this way, the success of those who "passed the test" and obtained high status professions is legitimated, while those less successful students interpret their less prestigious occupations as equally well deserved.

The problem with sociological discourses is that they attempt to present social and cultural groups as unitary, in much the same way as psychological theories attempt to present child development as a universal truth. Whereas sociological discourses focus on the wider social structures, thereby largely failing to account for the potential of human agency in the construction of mathematical meanings, psychological discourses focus at the level of the individual failing to explain how wider social structures constrain cognition. For example, Willis' (1977) study of a group of English working class boys proposed "the lads" actively rejected the ideology of schools, suggesting that they understood the function of school. Yet their affiliation with their working class roots ensures the stratification of society. Effectively their culture affected their perceptions to such an extent that they could not see the connection between schooling and social mobility. So while Willis attempted to explain the potential of human agency, he could not account for the constraints that the social origins of "the lads" had on their selection of possible options.

The limitations of sociological discourses is their tendency to examine the social structures, without acknowledging the role that the individual has in the process of meaning making. It is almost as if belonging to a working class culture will ensure its children will not be successful in their study of mathematics. Yet invariably, there are those people who, in spite of their social background, are able to be successful in mathematics. Sociological discourses are restrictive in explaining this phenomenon.

MacLeod's (1987) ethnographic study offers an account of two groups of students who in spite of sharing the same social and geographical location, or *habitus*, (Bourdieu, 1977), adopted different sets of attitudes and actions towards school which lead to different outcomes. This study challenges the somewhat deterministic proposals of sociological discourses, indicating the potential of human agency in the construction of meaning and social advantage. In order to develop a more holistic understanding of the construction of meaning, it is necessary to incorporate both the individual as well as the social dimensions of learning. What meanings are constructed are influenced by the individual construction processes, which are either facilitated or constrained by the wider social structures. Only when these have been combined will it be possible to understand how and why knowledge is constructed the way that it is.

BEYOND STRUCTURALIST DISCOURSES

The discussion of psychological and sociological discourses gives rise to a more general notion of epistemology. Both these approaches engender the reification of either the individual or the social respectively, so that the approaches are limited in their account of meaning making. The imputation of generalised cognitive stages onto the individual suggests that all children must go through certain characteristic phases of learning. Stage theories suggest that there are generalised cognitive structures that pertain to all people regardless of gender, race or class. These structures influence or constrain cognition is certain ways. Similarly, the sociological theories of mathematics education also impute generalised characteristic features to social groups. They tend to reify social class as a unified structure so that individuals are seen to be generalised.

To this end, any adequate account of mathematical learning needs to account for both the social and the individual in the construction of meaning. In this way, in order to understand the non-random failure of working class children, or any other socially marginalised group, it is necessary to develop a framework that will permit the mutual constitution of the individual and the social in the construction of mathematics.

From my point of view, success in mathematics is a product of socially negotiated meanings. Certain practices produce certain results, which in turn are interpreted in different ways by different people. How does a teacher know what a child knows in mathematics? How the teacher interprets what the child says may be influential in how the child is perceived by the teacher in later interactions. Similarly, how the child perceives the teacher and the task will influence greatly the responses that the child will make. There is immense ambiguity in students' actions and teachers' interpretation of those actions. How teachers' practices are organised will have an effect on student outcomes. Thus, to understand the production of meaning and social advantage it is necessary to move beyond structuralist notions of learning to examine the social practices in which the learning of mathematics occurs and how that learning is legitimated. This can be reflected in the following comment:

To understand social inequality and the school's contribution to it, we must collapse the macro-micro, agency-structure dualism by showing how the social fact of inequality emerges from structuring activities to become external and constraining on social actors. (Mehan, 1992, p. 17)

Inequality in a society is constituted through certain social practices and if we are to understand how social inequality is produced by and through mathematics discourses, then it is necessary to examine those discursive practices which construct, and regulate, social inequalities. In order to do this, it is necessary to adopt a discourse and research methodology that attempts to unite the psychological, or individualistic, discourses with the sociological discourses. Inevitably, this means moving beyond structuralist discourses.

I am proposing that what is often seen as "talent" or "ability" or "intelligence" in mathematics is not natural nor given, but rather is a social or cultural notion and is the product or outcome of social arrangements. These arrangements are often institutionalised and have a long history associated with them. The research that I am undertaking is to identify and critically examine the practices that have an influential role in the construction of success in mathematics.

CONSTRUCTION OF SUBJECTIVITY

To contextualise this proposed research, a series of incidents occurred that were inter-related and contributed to the construction of "ability." By examining the events that occur, how these are interpreted by the teacher and the actions that are evoked, allows some understanding of how "ability" is constructed as a result of these practices. It is also necessary to undersand how these practices are connected to the institutionalised practices of the school. These practices effectively construct the students' mathematical subjectivity.

One school participating in the research is an independent school servicing the "middle to upper" classes. There are twelve students in the class, predominantly male. During a lesson on place value with grade one children, three groups rotated around the class of which one of the activities required the children had to indicate the number of ten and units in the numbers from 20 to 11. The first group to engage in the activity quickly completed the task and were left to draw pictures on the reverse side of the worksheet. The strategies which this group used involved doing the first two or three tasks, then guessing the pattern and filling the rest of the sheet in. One child was repeating the year level, so had some familiarity with the concepts. In responding to my comment that this group may have used other strategies than that which she had envisaged, the teacher responded that this was a very bright group of children and would have no problem with the task. For them, she thought the task was consolidation that which they already knew. She then took one boy out of the group and using the counting frame, she asked him to show her 13. The child then proceeded to move 3 groups of ten beads over and count out 5 on the fourth row. She then suggested he start again and repeated the question, this time emphasising the three. The child again moved 3 groups of ten out, but counted out three. Very quietly, she suggested that he listen carefully and try again. Again he moved out 3 groups of ten and hesitated before moving out the fourth row. At this stage, she intervened and said "Are we looking at thirty or thirteen?" with the emphasis on thirty and the teen of thirteen, and then paused. The child then hesitatingly removed the three rows of ten and placed one row of ten out on the bead frame. At this point she interjected and said " That's right." The child then slowly began to count out more. She congratulated him on his "success" when he had counted out three.

The second and third groups to engage in the same activity used concrete materials (Unifix blocks and bead frames) and took the entire time to work out the task and then with a number of them not completing the task. Those boys who did not complete the task were explained as being her "slowies" and had a few "learning problems." She hastened to add "These kids probably would be seen as normal in the state system." The other children were described as "pretty bright kids." She worked with these children intermittently during the lesson. However, the interaction with these children was somewhat different to that with the earlier child. Her instructions were far more directive as can be seen from the extract below[1].

T: Put out 19
(child puts out 20 beads)
T: No, we don't want that, that's 20.
(T puts out 10 beads)
T: What comes after 10?
C: 20?
T: Does it? What about 11?
(Child beings to count out single beads)
C: 11, 12, 13, 14, 15, 16, 17, 18, 19
T: Right. Now many groups of ten?
C: One
T: And how many little ones?
C: 1, 2, 3, 4, 5, 6, 7, 8, 9
T: 9, right, put it down here. Now this one's not right....Put out 18. Now you know you've got 10 here. What comes after 10, 11?
C: 11, 12, 13, 14, 15, 16, 17, 18
T: Now that's what you want. How many groups of ten?
C: 1
T: O.K. one. Put it down and how many little ones?
C: 1, 2, 3, 4, 5, 6, 7, 8
T: 8, O.K. put it down.

It is apparent that the interaction between the children is substantially different. In the earlier interaction the child is allowed to be hesitant and quite clearly incorrect, even though he had completed the task. The teacher repeatedly rephrased the question to allow the child to reconstruct an appropriate response. Conversely, the second child is quite abruptly informed of his mistake when asked "What comes after 10?" In the context in which it was asked, it would seem quite legitimate that the child could have easily mistaken the question for either of two questions. The first whereby the teacher was counting in tens since the first number she called was ten. Alternatively, the child could have mistaken the question to be referring to the previous task which required to find out how many tens in 20.

From these incidents, it seems that the teacher in certain ways labels the children which structures learning environment for them in substantially different ways. In turn, this also

[1] In this extract T is used to denote the teacher and C to indicate the child

structures how success is also translated for these children. This impacts on their learning of mathematical concepts, as well as their perceptions of themselves in particular, and mathematics and school in general. By positioning the children in discursive practices, it would be reasonable to expect different outcomes for the teacher as well as the student. It appears that the labelling of children in certain ways will influence how the teacher interprets their behaviour which, in turn, will insert them into different discursive practices.

By the time these children reach year 7, they are unashamedly streamed for high school mathematics as the mathematics co-ordinator commented that "It is impossible to teach to different abilities in mathematics. This is why kids in the state system don't do as well in mathematics." This streaming is based on individual test scores in conjunction with teachers' subjective interpretation of the child's performance. There are three streams which range from advanced maths to repetition of grade 4 and 5 work. In spite of how a child performs on the exam, a teacher is able to comment and recommend that the child be put into a certain stream. In this way, the subjective interpretation that a teacher has for any given child will influence the discourses to which the child will be exposed. In light of the previous experience, it is possible that the interpretation that the teacher has of a student early on in his/her school career may see them inserted into different practices which inadvertently will expose them to different experiences. By the time they begin post primary mathematics, they may have had their mathematical "ability" constructed for them as a result of these earlier experiences.

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