CHAPTER 1

MATHEMATICS LEARNERS IN TRANSITION

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1. RECENT SOCIOCULTURAL CONCEPTUALISATIONS AND DEVELOPMENTS

Formal, non-formal and informal mathematics[1] education practices continue to evolve through globalisation and through the use of technology and the WWW. They do so in response to the need for more mathematics to be learnt by increasing numbers of students, both school students and adults. As these practices develop, and as adult education and life-long education grow in importance, along with their mathematical versions, there is an increasing need for mathematics education to move away from ideas and practices based on traditional child development theories and normative ideas. This is particularly important if research in mathematics education is to continue to have relevance and influence in these new and diverse fields of activity.

In the last two decades educational and psychological research studies on social, cultural and political aspects of mathematics learning, have raised awareness of the complexities of the process of learning and using mathematics in specific sociocultural practices (see for instance, Bishop, 1988a, 1988b, 1994; Secada, 1992; Van Oers & Forman, 1998, Cobb & Bauersfeld, 1995; Lerman, 1994). On the other hand such studies have also indicated the potential of this field for informing and developing teaching practices at all levels of mathematics education.

[1] This triad of terms is best defined in Coombs (1985), where formal is what happens in required schooling, non-formal education is what happens in non-required courses and structured educational provision outside and after formal schooling takes place. It could include after-school programs, trade courses, university courses etc. He describes informal education as being non-structured and non-required, such as may be obtained from peers, from TV, libraries, WWW etc. Bishop (1993) applies these definitions to different forms of mathematics education. Nunes et al (1993) distinguish between formal and informal education while Coombs' distinctions separate their 'formal' into his two categories of formal and non-formal. However Nunes et al. (1993) also point out that it is important to bear in mind that informal is defined by exclusion, that is informal mathematics, in their terms, is what is not learned at school. Coombs also makes the additional point that as demands on formal education have increased during the last decade so non-formal and informal education have both expanded to meet the increased need.

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For example, recent studies have:

- documented the wealth of mathematical knowledge accumulated over history by specific cultural groups,
- identified relationships between logical and social organisation of specific cultural tools and individual's thinking processes,
- given some indication of the relationships between the ways knowledge is valued and the mechanisms which can lead to social inclusion or exclusion, and
- informed the development of theories of situated learning.

To achieve such a state of knowledge researchers had to be selective and sometimes have undertaken studies on individual and isolated practices. Some relevant examples here are the studies on 'everyday cognition' focused on out-of-school practices, such as tailoring, farming, cooking, street vending, etc., (see for example the research summarised by Nunes, Schliemann & Carraher, 1993; Barton, 1996).

Focusing on individuals engaged in a particular sociocultural practice has been very important in producing evidence of the existence of legitimate forms of mathematical knowledge other than school mathematical knowledge. However, our concern with these studies is related to the fact that individual learners and societies are not static entities, but are dynamic. Moreover it is our belief that neither ontogenetic (individual development) nor sociogenetic (social group development) aspects of change are properly accounted for by current ethnomathematical or sociocultural theories.

Developmental psychologists working within an individual tradition are also questioning the discrepancy between the explanations produced by researchers and the observed 'facts' in the real world. Siegler (1996) made his point by asking: 'whose children are we talking about'. He doubted it was his children! For him the crucial research challenges lie in explaining these three aspects of learning: **variability**, **choice** and **change**. This is certainly not a problem which is restricted to Siegler's information processing approach. Situated cognition and other sociocultural accounts of cognition also have not provided adequate accounts of any of those three aspects (Abreu, 1995).

Firstly, sociocultural accounts have not yet provided satisfactory accounts of ***variability***. Although a focus on diversity has been a central issue in the agenda of approaches to learning and development from a cultural psychology perspective, like other branches of empirical psychology it has tended to explore differences between groups, and left un-analysed any within-group and within-individual differences. It is unclear why the same person can use mathematics competently in one practice, e.g. street mathematics, and then experience tremendous difficulties in learning the mathematics associated with another practice, e.g. school mathematics. It is also unclear why some people from similar backgrounds show one pattern of performance across practices, e.g. some are competent in both, while some show another pattern, e.g. they succeed only in one. This lack of explanation leaves the situated cognition accounts too vulnerable and opens a space for this diversity to continue being 'explained' in terms of a biological basis.

Secondly, ***choice*** and agency, were not central issues in the theoretical and empirical developments in situated cognition. In general the studies channelled their efforts into demonstrating that individuals and social groups have the ability to learn. The methodological choice for the researchers was a focus on a microanalysis of the mathematical competencies of individuals engaged in specific, very often non-mainstream, and low-status, practices (e.g. street children in Brazil). However, social psychology has for a long time demonstrated that even minority groups are not passive, and it is time for learning theories to try to understand the processes of agency at group and individual level (Moscovici & Paicheler, 1978). As several authors have been stressing, the problems of power, access and transparency of how one becomes a member of a community of practice need to be addressed (see for example Goodnow, 1990; Lave & Wenger, 1991).

Thirdly, sociocultural accounts have been criticised for their limited or biased accounts of ***change***. When focusing on the practices, very often these were described in rather static ways, that is they captured the traditional side of the practice but paid no attention to innovation and change (Abreu, 1998). When focusing on the individual, the tendency is that the accounts of change portray patterns, but less attention is paid to the uniqueness of changes in actual individuals. Also very little attention is paid to any conflicts that may occur between the cultures experienced by the learners inside and outside the school (Bishop, 1994).

Authors following approaches that centre around understanding the emergence of new meanings at the individual level (Cobb, 1995), or at the social group level (Duveen, 1998), suggest that the focus on reproduction of the traditional, i.e. the homogeneous side of cultures and societies, can be linked to particular uses of Vygotsky's ideas. Bruner (1996) also argues that a focus on the cultural symbolic systems is not sufficient to explain learning in modern plural and rapidly changing societies. For him 'nothing is "culture free", but neither are individuals simply mirrors of their culture. (...) Life in culture is, then, an interplay between the versions of the world that people form under its institutional sway and the versions of it that are product of their individual histories' (Bruner, 1996, p.14).

Finally, researchers interested in the emergence of new meanings in mathematics tend to emphasise the importance of communication, negotiation and interpretation (Bishop & Goffree, 1986). Meaning-making processes are however very enigmatic (Wertsch, 1991). Although most authors tend to agree that the meanings that the person brings to a situation influence the course of learning, we still know very little about meanings that are not just cognitive.

Bruner's view that the meanings that a child brings to a situation 'are not to his own advantage unless he can get them shared by others' (1990, p. 13) seems to us extremely important. Contextually-bound and socially shared meanings concerning such phenomena as language use, appropriate behaviour, values, and customs are crucially important factors in learning. They may indeed be more important when intercultural communication and interpretation are involved. For example, Pinxten (1994) characterises what he calls Navajo learning in these terms:

- More emphasis on qualitative ordering and aesthetic aspects and less on quantification and universal statements,
- More stress on orthopraxy (to behave properly, appropriately, and so on) and less on orthodoxy (to share the same contents as the other members of the group),
- More dependence on the persons involved in knowledge transfer, and much less room for a curriculum format and hence for a universal status of knowledge,
- More awareness of the negotiation aspects of each learning situation and less respect for the institutional authority of a teacher. (p. 88)

Walkerdine (1988) in her seminal work 'The Mastery of Reason' also concurs with Bruner in illustrating how Western school practices regulate what comes to be seen as the 'right meaning'. She suggests that schools do not enter into a process of negotiation which helps the learner to construct chains of signification, where concepts and mathematical objects can acquire multiple meanings, legitimated by the contexts in which they are used. Instead, she argues that schooling 'empties' and 'represses' the multiple mathematical meanings acquired outside school in order to replace them with a unique and presumably disembedded meaning.

Evidence from empirical studies, however, suggests that this is not the whole story (see Abreu, 1995; Planas, Vilella, Gorgorió & Fontdevila, 1999; Presmeg, 1998). Learners continue to bring meanings into their mathematics lessons, although most of the time this can occur in 'silence'. Learners clearly negotiate much of the learning process as well as the content being learnt. For example it is also not unusual to hear accounts from well-intentioned teachers about the refusal of their students to use outside school knowledge in the classroom. However what we need to know in order to provide any learner with learning environments conducive to expression, sharing and negotiation of meanings still seems to be an open question.

We believe that:

(1) it is necessary to get insights into the dynamics of mathematics learning of individuals who might behave and apprehend meanings in situated ways, but who certainly move across the different practices and institutions of societies, that are themselves continually in the process of change, and

(2) it is therefore necessary to focus on analyses of how individuals and/or social groups experience their participation in, and transition between, more than one sociocultural mathematical practice.

This then is the focus of this book: the idea of transition in mathematics learning, particularly of mathematics learners in transition, and of their transition between different contexts for mathematics learning and practice.

2. TRANSITION – PRELIMINARY DEFINITION AND WORKING NOTIONS

In a certain way this book also tells a story of a group that has been connected by their shared research interests. Our adoption of the notion of transition as a central construct in our work, and the way it has been evolving, also reflects the developing process of the group. In retrospect most of us feel the way we see transitions now is quite far away from where we started. In this section we tell a bit of this story: how it emerged; where we looked for inspiration; and how we proposed to approach it. We believe that this background is important in enabling readers to evaluate the general validity of the ideas the group has generated.

2.1. THE EMERGENCE OF THE NOTION OF 'TRANSITION' AS AN INTEREST OF THE GROUP

The focus on understanding how participation in home mathematical practices that are distinct from school mathematical practices impacts on the learner has been central to the research of most of the contributors of this book for quite a long time (see for instance Abreu, 1995, 1998; Abreu, Bishop, & Pompeu, 1997; Bishop, 1994; Presmeg, 1988). However, our use of the notion of transition to help to theorise this relationship is recent. Although it is difficult to be precise about when we started using this concept, the re-construction of the history of this book leads us to believe we first used it based on common sense. It seems we took for granted, as many social scientists do, that the meaning(s) of the word was shared during our discussions.

We vaguely defined it in our initial group meeting and outlines. It is certainly not difficult for us to identify the phenomena that for us are disturbing. All the contributors to this book have dedicated a part of their lives to understanding why particular groups of learners have difficulties with their school mathematics learning. Though we manage to provide evidence that these learners are capable of mathematical thinking in their home and other environments, we are still a long way from clarifying for teachers why they continue to have difficulties in more formal learning situations such as at school. This gap in our knowledge is disturbing not only for us as researchers and educators, but also for classroom teachers for example, who reject theories of deficits in the child, only to find themselves in a position of not knowing what to do to help the child progress at school.

The idea that we had in mind was that our problem required investigations that go beyond a focus on single practices. Participation in multiple social practices requires the person to move between them and this movement needs to be understood. From movement between contexts of practices we progressed to the notion of transition. Or indeed 'transitions' in the plural, in the sense that from the beginning we also assumed a person can move between various contexts (e.g. home, school, peer groups, etc.) and also that there exist various types of transitions (e.g. linguistic, social, cultural, etc.).

Other key assumptions in the development of our thinking were firstly, that the movement between practices required the theorisation of both the social environment and the individual learner as dynamic entities. Secondly, in accordance with our view that multiple mathematical practices co-exist in society, we were interested in transitions as bi- or multi-directional trajectories. In taking this view we were departing from a common use of the concept of transition in the traditional develop-

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