Adult Maths and Everyday Life: Building Bridges, Facilitating 'Transfer'

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How should we teach mathematics so as to support adults' functioning satisfactorily in their work and everyday lives? We can draw on the range of activities that the typical adult is involved in, but this range will vary greatly across the group in a typical basic education or college pre-calculus course. Thus, the mathematics taught must be able to be 'transferred' or generalised to their contexts. My approach to this problem provides a critical alternative, both to traditional transfer theories and to situated cognition, in showing learners and teachers how to build bridges between different practices, particularly between school or college and work.

Introduction

The *transfer* (or generalisation) of learning means the use of ideas and learning from one context in another. This might involve:
(1) the *harnessing* of out-of-school activities and thinking in the teaching of college subjects;
(2) the *application* of learning from college contexts to work or everyday activities; or
(3) the use of a school subject like mathematics outside of its own domain, in nursing, engineering or business studies (cf. Maas, 1998).

This is clearly an especially important set of issues for mathematics since it is claimed to have wide applicability across the curriculum, and outside the school or college. Yet students often 'fail' to accomplish transfer. And views on the reasons are in conflict, leading to widespread controversy.

Views on the Transfer of Learning in Mathematics

The discussion has been vibrant not only in psychology, but also in education in the last 10 or 20 years. Here *traditional* approaches include views favouring the use of behavioural learning objectives, "basic skills" approaches, and "utilitarian" views (e.g. Cockcroft Report, 1982). They share several ideas. A problem or "task", and the mathematical thinking involved, can be described in abstract, e.g. as a 'percent', or a 'proportional reasoning' problem; hence it is claimed to be possible to talk about "the same mathematical task" occurring across several different contexts. For traditional views, that the "transfer of learning", e.g. from school to everyday situations, should be relatively straightforward - at least for those who have 'understood' the maths properly.

However, there are problems. As indicated above, one cannot *depend* on transfer being accomplished, by a particular learner, in a particular situation. And recent research has shown striking differences between performance in school tasks, and that in work, or everyday situations (e.g. Lave, 1988; Nunes at al., 1993).

Thus critical positions have emerged - in particular, the *strong form* of situated cognition. Its proponents argue, citing Jean Lave *(1988)*, that there is a *disjunction* between doing maths problems in school, and in everyday life, as these different contexts are characterised by different *structuring resources* (e.g. ongoing activities, social relationships). Subjects' thinking is *specific* to these settings, and to the different practices in play in them. Thus transfer of learning from school / academic contexts to outside ones is pretty hopeless.

However, there are problems with the situated cognition account, too. First, in its strong form, the view threatens a cul-de-sac: we are offered a proliferation of differently situated types of mathematical thinking, with high boundaries between them, and claims that the use of one type of thinking in another context is basically impossible (cf. Noss & Hoyles, 1996b, ch.2). Second, this approach seems to assume that practices and communities of practice can be seen as 'natural' - whereas I argue the need for description and *analysis* of the bases of different practices - in language or 'discourse'.

Meanwhile, Jean Lave's more recent work (Chaiklin and Lave, 1993; Lave, 1996) has moved on, acknowledging that no practice could ever be completely closed, or completely separated from other practices.. Her approach consists of studying learning within communities of practice, and the social relations, and identities across them.

This brief discussion (see also Evans, 1999a) suggests a need for a reformulation of the problem of transfer. Four crucial issues are discussed in the next section. Currently, a number of areas, besides mathematics education, are contributing to this reformulation, including developmental psychology (e.g. Nunes et al., 1993) and cognitive psychology (e.g. Anderson et al., 1996), and sociology of education (Muller and Taylor, 1995); see below. My approach further draws on discourse theory and poststructuralism; see e.g. Walkerdine (1988); Walkerdine and Girls & Maths Unit (1989); Evans and Tsatsaroni (1994, 1996); Evans (1999a, 1999b).

Conceptualising Boundaries and Bridges

(1) how to characterise and differentiate the various contexts of thinking, activity and learning, and the related practices at play in them

In my approach, *practices* are activities such as school mathematics, research mathematics, nursing, banking, apprenticeship into tailoring, and shopping. Each practice is constituted by *discourses*.

Discourses are systems of ideas expressed in terms of *signifiers* and *signifieds*; signifiers are words, sounds, gestures, etc. and signifieds are conceptions, or what is meant. These discourses give *meaning* to the practice by expressing its *goals* and *values*, and *regulate* it in a systematic way, by setting down standards of performance. Within a community of practice, there is a set of social relations (power, difference) - with different members of the community taking up different *subject-positions*. For example, the basic positions available in school mathematics are normally "teacher" and "pupil"; in shopping or street-selling, they would be "seller" and "buyer".

This approach, like situated cognition, recognises different practices as in principle distinct - e.g. school maths and everyday practices like street selling. But, my approach aims to avoid the *cul-de-sac* (see above), and to go further - by analysing the discourses involved through their relations of signification - relations of similarity and difference between signifiers and signifieds, and also devices such as metaphor and metonymy. So far this draws on de Saussure's structural linguistics. Going further, poststructuralist ideas about the inevitable tendency of the signifier to slip into other contexts, thereby making links with other discourses, and producing a play of multiple meanings, provide insight into meaning-making in mathematics; see the discussion of "shopping with mummy" below, and also e.g. Walkerdine (1988, Ch.2) on children's use of language to indicate relations of size, Brown (1994) and Evans and Tsatsaroni (1994, p.184).

Thus, rather than attempting to specify the context of a school maths problem by looking only at its wording - or by naming the context as if simply based in "natural" settings, as researchers we can describe it as socially constructed in discourse. This means:
(a) analysing the practices at play in the context, that would be involved in the 'positioning' of participants (Evans and Tsatsaroni, 1994); and
(b) attending to particular signifiers and their relations of similarity and difference, e.g. in reading interview transcripts.

(2) how to describe the relations between practices, and communities of practice, e.g. the boundaries or bridges between them

Contrary to the hopelessness of the strong form of situated cognition, I aim to build bridges between practices, by identifying areas where out-of-school practices might usefully "overlap" or inter-relate with school mathematics. This requires first of all that distinctions are made between those relations of signification in the learner's everyday practices that provide *fruitful* 'points of inter-relation' with school maths, and those that may be *misleading*. An example of a misleading inter-relation would be the attempt to harness the use of "more" in the home - where its opposite is *no more* (as in "no more ice cream for you") - to help teach "more" vs. *less* as an oppositional couple at school. The pupils are likely to be confused because what appears to be 'the same' signifier has a different meaning (signified) in the home and the school discourses (Walkerdine and Girls & Mathematics Unit, 1989, pp.52-53).

Thus, Walkerdine argues that activity within one discourse - say, playing a particular card game - will help with (i.e. can be "harnessed" for) school maths in those, and only those, aspects of the game which are both contained in school maths and which enter into *similar* relations of signification (Walkerdine, 1988, pp. 115 ff.). This would suggest that knowing the order of precedence among the 13 cards of a traditional deck (2,3,4, ...

9,10, Jack, Queen, King, Ace) would help a child to learn to count (1,2,3,, ...) - but only up to a point. There are *similarities* in the identical orderings of cards and natural numbers between 2 and 10 - but, also, especially, the *difference* between the Ace and '1' must be made explicit. So we can broaden Walkerdine's stipulation of 'similar relations of signification' to mean 'similar or specifiably different'.

(3) acknowledging the importance of affect, motivation, etc.

Most accounts of mathematical thinking, including situated cognition, largely ignore the area of emotion. But "meanings are not just intellectual" (Walkerdine & Girls and Maths Unit, 1989, p.52). Thus, whenever a teacher reaches outside of mathematics for an example as illustration, the mathematics is "at risk"; e.g. when illustrating maths in the context of shopping with "Mummy", if the mother "has financial difficulties, ... is sick far away or deceased" (Adda, 1986, p.59). This is because of the fundamental character of language, its ability to produce "multiple meanings", as argued by poststructuralists (se above). Thus another reason that a particular set of relations of signification may not succeed in attempts to *harness* everyday life for school purposes, is that these relations may be *distracting* or *distressing* - and not only misleading.

Affect can be seen as the energy that powers reason (Buxton, 1981). Here, affect is understood as an emotional charge attached to particular words, gestures, and so on. This charge can flow from one signifier to another, along *chains of meaning*, by *displacement* (Evans and Tsatsaroni, 1996, p.355). (NOTE 1)

The quality and intensity of affective charges may often be a major influence in the success or failure of many attempts at transfer - an influence that has so far been largely ignored in the mathematics education literature.

Implications for Teaching

(4) designing pedagogic practices that will facilitate harnessing and transfer

Besides seeking out fruitful (non-misleading, non-distracting) points of inter-relation, we must structure the pedagogic discourse so as to work systematically through a process of 'translation'. This involves a series of steps, where the signifiers and signifieds linked in one set of signs are transformed into a new set of signs, thereby creating new meanings. The several steps are held together by *chains of meaning* (Walkerdine, 1988, p.128ff.).

A simple example is that of a mother who, in discussing with her child the number of drinks needed for a party of the child's friends, manages to teach the child to count - by the following transformations from one step to another (Walkerdine, 1988, p.129):

Step
1 Child (*signified*)
Name (*signifier*)

2 Name (*signified*)
Finger (*iconic signifier*)

3 Finger (*signified*)
Spoken Numeral (*symbolic signifier*)

4 Spoken Numeral (*signified*)
Written Numeral (*symbolic signifier*)

At the first step, the mother-teacher, encourages the child to form a sign linking the name of each child (*signifier*) with the "idea" of that child (*signified*). At each subsequent step, a new signifier (gesture, numeral) is linked to a new signified, which had been the signifier at the previous stage; each step thereby creates a new set of signs. The chain of meaning moves as follows: actual child (more precisely, *the idea of* the child) - name of child - iconic signifier - spoken symbolic signifier - written symbolic signifier.

Here, the different steps do not really represent different discourses, but they nevertheless show how a series of carefully constructed links between signifiers and signifieds could provide the bridges for crossing boundaries between discourses - here, between home practices and school maths.

Schliemann (1995), in a paper concerned with the viability of harnessing maths from everyday settings to help with learning school maths, reaches a conclusion similar to Walkerdine's (above) about the necessary conditions for transfer or generalisation:

... mathematical knowledge developed in everyday contexts is flexible and general. Strategies developed to solve problems in a specific context can be applied to other contexts, *provided that the relations between the quantities in the target context are known by the subject as being related in the same manner as the quantities in the initial context are*. (p.49, my emphasis; NOTE 2)

A set of useful guidelines for teaching / learning for transfer, can be based on the analysis above, and augmented from Anderson et al. (1996). An important principle is clearly to show learners how to perform a detailed analysis of the shared or similar components - *and the different aspects* - of the initial and target tasks. For a fuller discussion, see Evans (1999c).

Implications for Research

In order to specify the context of a maths problem attempted in a particular setting, some of our research effort must be aimed at producing and analysing interview transcripts. To illustrate, I include a brief reference to one of my own research interviews: the responses of "Donald" to one of the problems presented to a sample of social science undergraduates - which concerned a graph showing how the price of gold varied over one day's trading in London (Evans, 1998, 1999b).

For these interviews, two practices were judged to be 'at play' - on the basis of the setting, the language used in the letter of invitation, the interviewer's scripted talk, and so on. These two discursive practices were 'college maths' (CM) and 'research interviewing' (RI). In addition, I judged, mostly from the particular subject's talk, what was the 'predominant positioning' of each during each crucial episode of their interview. In general, RI was considered to open up the possibility of the subject's positioning being in a practice from their non-college or previous 'lives'; for the graph question, this non-college practice was often a business practice of some kind.

The interview analysis shows several things:
(1) Donald is apparently able to focus on *discursive similarities and differences* between college maths and business maths (BM). He seems able to read the diagram as a "chart" (BM) or as a "graph" (CM), and to recognise the connections between a "trend" and a "gradient" (respectively).

(2) He is also aware of the different objectives in using the graph. In *business*, the objectives are competitive, to make comparisons across personnel or groups, or over time; in *college maths*, the objectives are more analytical, focused on the qualities of the curve, including the rate of change. He is aware of *different values and standards of regulation*, in particular of *precision*, required in the two discourses.

(3) He is also open about the *different feelings* evoked by the two practices. For example, his awareness of the different goals of the two practices (see above) is sometimes painful (Evans, 1998, 1999b).

(4) He is able and willing to use both college maths and money-market maths. Further he seems able to choose which practice to use to address the problem in the interview, to decide whether or not to apply his (more precise) college maths methods of calculating gradients to the problem of saying during which period of the day the price of interest was rising faster. Though not certain, it also appears that Donald is able to bridge the two practices, i.e. to transfer his college maths methods to deal with a problem involving charts, assuming he was convinced of the need.

Conclusions

1. Continuity between practices (e.g. school and out-of-school activities) is not as straightforward as traditional views assume. Hence scepticism is in order about claims that transfer is in principle straightforward.

2. Like situated cognition researchers, we can acknowledge at least that transfer is not dependable and often difficult. But it is not impossible, and hence we can be more optimistic than these other approaches suggest.

3. In teaching and learning, bridges between practices can be built, by analysing the

similarities and differences between discourses (e.g. school vs. everyday maths), so as to identify fruitful "points of inter-relation" between school maths and outside ("target") activities.

4. The inter-relationships of thought and feeling have received insufficient emphasis in most discussions of transfer. They are important because they contribute to the inevitable tendency of language to flow in unexpected ways and generally to assume multiple meanings within different practices - which constitutes a severe limitation on the possibilities of any intended transfer.

5. Yet this ability of a signifier to form different signs also provides the basis for any transfer possibilities. Thus, though the successful crossing of bridges cannot be guaranteed "risk-free", this paper has sketched some steps it is *necessary* to follow. Thus, for anything like transfer to occur, a "translation" across discourses would have to be accomplished, as summarised in (3). This translation is not straightforward, but it often will be possible.

6. We need further study of transfer from school to work, including a focus on sign systems, and more widespread workplace studies in the styles of Recife (e.g. Nunes et al., 1993) and the London Institute (e.g. Noss and Hoyles, 1996).

7. Given the links between the notion of transfer and the traditional views criticised above, as well as widespread dissatisfaction with the notion (e.g. Lave, 1988, 1996), I propose that the term should be replaced either by 'translation' or by 'generalisation'.

Notes

1. Indeed, insights from psychoanalysis can allow us a fuller consideration of the affective (Walkerdine, 1988; Evans and Tsatsaroni, 1994, 1996).
2. As with Walkerdine's position, I would want to broaden Schliemann's stipulation of 'the same relations of quantities' to mean 'similar or specifiably different'.

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