Abandoning Mathematics and Hard Labour in Schools

A *new sociology of knowledge* and curriculum reform

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The expression 'new sociology of knowledge' is emphasised in my title because it could, in terms of what I want to say, stand as the whole title. The main title is a proposal that derives from my sociology; that which follows 'new sociology of knowledge' is perhaps something of a wish, a wish that, looking at the curriculum from this sociological perspective might lead to a change; as a sociologist, I am not optimistic. As for 'knowledge', this, ironically, is not to be thought of as the object of my sociology, so much as that which is imagined by the practices that I want to consider; it's a myth.

For a general audience (and perhaps for a less general audience as well), I should explain what I mean by 'sociology'. This is how I described it in 1998:

> By the use of this term I mean that the theoretical space in which I am interested is concerned with patterns of relationships between individuals and groups and the production and reproduction of these relationships in cultural practices and in action. (Dowling, 1998; p. 1)

More recently (for example, see Dowling, 2009) I have taken to borrowing from cybernetics and describe the theoretical space—the sociocultural—as that which is defined by strategic, autopoietic action directed at the formation, maintenance and destabilising of alliances and oppositions, the visibility of which is emergent upon the totality of such action, rendering them available as resources for recruitment in further action—same thing, really. This is my central principle or 'guiding thread', but it is also important to make explicit what I take to be the status of the work that I produce: essentially, what I am aiming to do is generate principled interpretations of the empirical, the principles being constituted as a developing theoretical framework, or method—*social activity method*, SAM. The approach makes no claims to exclusivity, either theoretically or empirically; its deployment is interrogative, rather than prescriptive; and its use-value is to be assessed pragmatically. SAM is not science, but then, as has been widely documented, science is not science, in terms of the stereotypical ways in which we frequently think of it, either.[1]

What I propose to do in this paper is to present an interpretation of school mathematics and, in doing so, also to introduce some of the theoretical structure that has arisen out of the transaction of my central principle with school mathematics as an empirical setting and that, only subsequently, motivates the interpretation. My general argument in this paper is intended to lead to the following conclusions. Firstly, school mathematics is better thought of as marking itself out from other practices rather than as functional to them; I shall refer to this as the prevalence of *disciplinarity*. This situation would seem to call into question the role of mathematics in holding a compulsory and core place on the school curriculum. Secondly, trends that privilege the use of metrics in public discourse on education may be leading to a change in the distribution of erstwhile elite performances in mathematics and in schooling more generally that I shall refer to as the *new massification* of schooling. To the extent that

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1 See, for example, Collins & Pinch (1998, 2005), Feyerabend (1975), Fleck (1981), Knorr Cetina (1999), Kuhn (1970), Latour & Woolgar (1979), Turnbull (2000).

this is a valid observation, schooling becomes less of a mechanism for selection and differentiation—perhaps other than at genuinely elite levels of performance—and more of an industry in service of governmental propaganda. Thirdly, I shall argue that it is the particular form of pedagogic relations in schooling that opens up a space for the development of the forensic science of assessment and the consequent mythologising of competence in the form of *conceptualisation*. In deconstructing this category in school mathematics I will argue that we need to move away from the dominance of *push* strategies that privilege the artificial subjects of school knowledge and towards a kind of practitioner-research-based curriculum that might more appropriately serve as an introduction to the diversity that is the collection of legitimate human activities.

A pedagogic device, recontextualisation and disciplinarity

A central point of departure for SAM is the work of Basil Bernstein (1971, 1977, 1990, 1996, 2000). I shall not reprise my engagement with Bernstein's theory here,[2] but will illustrate it by reference to and departure from his category, the pedagogic device. The device is analogous, in some respects, to Chomsky's language acquisition device (to which Bernstein (1990) makes explicit reference), except that it is a social rather than a psychological mechanism and, according to Bernstein, constitutes a site of struggle for those having objective interests in the form taken by schooling. The device comprises three sets of rules, rules of: recontextualising, distribution, and evaluation. Very briefly, recontextualising rules delocate discourses from their fields of production—the university, say—to establish pedagogic discourse within the field of reproduction—the school. Pedagogic discourse is distributed to school students, differentiated on the basis not only of age, but also of socioeconomic class, gender, and other objective categories of social difference. Finally, evaluation rules determine what counts as successful performances. This simple structure[3] is persuasive in the organising of descriptions of major curriculum developments, such as the modern mathematics movement of the 1960s, as I have illustrated in Dowling (2008a). The question, however, is what does this achieve? Bernstein's project is also one of interpretation, but his interpretive framework is too distant from the empirical. As I have argued in Dowling (2009), Bernstein's primitive categories—classification and framing—are too easily operationalisable through such oppositions as between/within, space/time, what/how and recognition/realisation so that they put no pressure on the empirical and, partly in consequent of this, fail to learn from it. The theory, like so much social theory, stands apart from the empirical.

Bernstein's theory is predicated upon generative social structures—such as the pedagogic device, but also more general characteristics, such as 'the division of labour in society'. It seems to me that the postulation of generative structures is radically inconsistent with an interpretive approach. Rather than inspiring interpretation in front of the empirical, so to speak, Bernstein uses data to illustrate or access causal entities that lie behind it; his approach is an example of what I refer to as forensics. In what follows, I shall attempt to illustrate the move from forensics to what I call constructive description. As I have indicated, my starting point will be the pedagogic device and its three sets of rules. A further concern that I have with the pedagogic device is the apparent arbitrariness of its threefold

[2] But see Dowling (2009), cc. 4 & 8 and also Dowling (1999).

[3] Bernstein's own description of the device is, as I have illustrated in Dowling (2009) often very confusing, with terms being used apparently inconsistently. Precision in its definition is not, however, crucial here.

construction. This is of crucial interest in respect of a theoretical construct; my approach strives to achieve motivated theoretical completeness. However, my departing from the pedagogic device will involve a shift into the empirical field, so that 'recontextualisation', 'distribution' and 'evaluation' will be taken to index three empirical sites. Completeness in the context of the empirical is addressed in terms of sampling strategies. However, I am not here aiming, here, at empirical completeness in terms of either representation or criticality (Dowling & Brown, 2010, see also Brown & Dowling, 1998), but intend, rather, to foreground conceptual interpretations.

The first component of the pedagogic device is its recontextualisation rules. For Bernstein, recontextualisation is achieved via the apparent action of the device—a social organ. My concept involves the transformation of a text or practice implicated in one activity by agents of another so that the text or practice is brought into alignment, in some ways, with the recontextualising activity. Clearly, we need to take a look at both activities in order to reveal the effects of recontextualisation. In order to do this, I shall consider a mathematics lesson described by Eric Gutstein (2002). Gutstein was concerned to get across the idea of expected values. His resources included graphing calculators and data on police traffic stops in Illinois and on the ethnic profile of the state. Gutstein explains:

> In mathematics, expected value is based on theoretical probability. If 30 percent of drivers are Latino, we would expect that 30 percent of random stops would be of Latinos—but only in the long run. This does not mean that if police made ten stops and five were of Latinos that something is necessarily out of line, but it does mean that if they made 10,000 stops and 5,000 were of Latinos, that something is definitely wrong. (Gutstein, 2002; no page nos)

In evaluating the lesson, Gutstein reports that:

> Students learned important mathematical ideas about probability through considering actual data about "random" traffic stops and compared these to the theoretical probability (what we should 'expect.') Graphing calculators can easily simulate large numbers of random 'traffic stops' (since they have a built-in 'random' number generator). (ibid)

What was learned is revealed in this 'fairly typical response' (ibid):

> I learned that police are probably really being racial because there should be Latino people between a range of 1-5 percent, and no, their range is 21 percent Latino people and also I learned that mathematics is useful for many things in life, math is not just something you do, it's something you should use in life. (ibid)

Emancipatory potential—albeit rather slender—was also apparent:

> What did emerge was students' sense of justice ('Why do they make random stops? … just because of their race and their color?') and sense of agency, as well as perhaps a sense of naïveté ('And Latinos shouldn't let them [police], they should go to a police department and tell how that person was harassed just because of a racial color'). (ibid)

The curriculum object—expected value—is explicit in Gutstein's text. Of particular interest, however, is the appearance of the term 'random', with and without quotes. The extracts seem to suggest that the police only pretend at randomness, whilst the graphing calculator is able to reveal what real randomness would look like using imagined 'traffic stops'. A mathematical and political success, it would seem.

But here's the thing: random traffic stops are illegal in the US, being a breach of Fourth Amendment rights; police have to be able to demonstrate probable cause for their interpretation that an offence has been committed.[4] In fact, one might suppose that police are often not able to estimate the ethnicity of a driver until after they have made the stop. This would seem to suggest that, if there is a correlation between ethnicity and the probability of being stopped, then we might look for the presence of intervening variables for an explanation; a correlation between ethnicity and relative poverty and the association of the latter with the use of elderly and poorly maintained vehicles having visible defects, for example.

Statistics can be used in all sorts of way, of course. One Illinois Department—the Wilmette Police—used their data on traffic stops to demonstrate that stops for different ethnic groups and genders were, in fact, in proportion to their representation in the community, thus demonstrating that 'Wilmette police officers are engaging in bias free traffic enforcement' (Carpenter, 2004; p. 66). One possible interpretation might be that, if the stops are non-random (as the law requires), then behaviour that might lead to a stop being made is evenly distributed in terms of ethnicity. Another might be that there has been some quota stopping going on.

My very brief discussion of this issue is intended to illustrate that, whilst statistical methods might usefully be deployed in the investigation and interrogation of the activities of traffic police, both the mathematics lesson and, in this case, the annual reporting of police activities by a police department, have privileged a particular object from probability theory—expected value—and, in doing so, have recontextualised police actions to the point of rendering them illegal! Rather more comprehensive reports are produced annually for the Illinois Department of Transportation (for example, Northwest University Center for Public Safety, 2007), again, though, the presumption that the expected value of stops for each category of driver is presented as the ideal state and any deviation is *prima facie* evidence of bias. We can describe what has happened here using the schema in Figure 1.

	Content (signifieds)	
Exprssion (signifiers)	I^+	I^-
I^+	*esoteric domain*	*descriptive domain*
I^-	*expressive domain*	*public domain*

$I^{+/-}$ represents strong/weak institutionalisation.

Figure 1. Domains of Action

I am conceiving the activity of mathematics education as a loose kind of alliance between mathematics educators that is characterised by a practice—school mathematics—that varies in terms of its strength of institutionalisation of modes of expression and of content (that which expressions signify). Those regions of the practice for which expression and content are most strongly institutionalised (I^+) form what we might regard as the non-negotiable part of school mathematics. I refer to this as the *esoteric domain* of the practice. Practitioners of school mathematics have been apprenticed into this domain in the sense and to the extent that it regulates what constitutes legitimate mathematical utterances and actions on their part.

[4] Decker *et al* (2004) do argue that US courts have been very liberal in respect of what might count as probable cause. However, the principle that there must be a reason for a traffic stop does undermine the assumption in the mathematics lesson that the stops are intended to be random; they are not.

But school mathematics should also be seen as a hybrid activity that articulates the strictly mathematical with what we might loosely describe as pedagogic theory (see Dowling, 2008b). The latter will require the active subject of school mathematics—for example, the teacher or textbook or test author—to cast a *gaze* beyond mathematics *per se* as has happened in Gutstein's mathematics lesson involving traffic stops data. The result is a recontextualisation of a police activity that brings it into alignment with the esoteric domain of school mathematics as mathematics. In fact, in this case, the recontextualisation has occurred in two stages: the first stage has involved the collection of statistical summaries of policing events; the second stage is Gutstein's recontextualising of these as a pedagogic resource. The first stage constitutes an illegal (ie random) ideal traffic stop and the second stage fixes this by its emphasis on its pedagogic objective, the expected value. Now, by and large, the language of the responses to Gutstein's lesson (as reported in his paper and illustrated above) was not couched in esoteric domain language: neither expression nor content are I^+ mathematical language, but look far more like everyday language, albeit rather politically charged. Here, expression and content are weakly institutionalised (I^-); this is *public domain* language.[5]

The two other domains presented in Figure 1 are hybrids. The *descriptive domain* employs mathematical language to refer to non-mathematical content. This is the language of mathematical modelling. The *expressive domain* deploys non-mathematical language to refer to mathematical content; this is the domain of pedagogic metaphors, a fraction is a piece of cake, an equation is a balance, and so forth (see Dowling, 1998, 2007, 2009).

Figure 1 allows us to talk in a consistent way about how one practice—here, school mathematics—talks about another. In the case of Gutstein's lesson, the public domain seems to be operating in a janusian kind of way. On the one hand, it is presented as a portal into the esoteric domain, 'Students learned important mathematical ideas about probability …'. On the other hand, students also got the political message, 'I learned that police are probably really being racial …', but looking outwards from mathematics. Whilst the esoteric domain objective is mathematically legitimate, the public domain message is suspect, to say the least; policing has been recontextualised to make both a mathematical and a tendentious, political point. You might learn mathematics like this, but you're going to get a naïve view of the non-mathematical world that it recontextualises as its public domain.

If it is the case—and I maintain that it is—that school mathematics always constitutes its public domain as a collection of distorted or mythologised practices, then this would seem to undermine the use-value of school mathematics as providing the basis for competences that can be transferred to other activities. This is not entirely my contention. Rather, school mathematics fails to provide transferrable competences in *push* mode, which is to say, the mode that characterises Gutstein's lesson in which mathematics—the pushing activity—is privileged at the expense of the object of the gaze—traffic enforcement. It is an empirical question as to whether mathematical competences may be productively useable in *fetch* mode, that is, from within another activity that is, so to speak, recruiting resources from elsewhere and that, of necessity, recontextualises them in this recruiting by privileging the fetching activity. I am inclined to the view that even in fetch mode, school mathematics is far less used than is often supposed by mathematics educators. Indeed, to the extent that all activities are dependent on the particularities of the contexts—performances being accountable within their respective alliances—that define them, then the whole idea of

5 In fact, public domain practice does not necessarily imply everyday language, merely language that is not I^+ in terms of mathematics.

transferrable knowledge and skills is problematised. Indeed, understanding practices as alliance/activity-specific entails that migratory competence is an imaginary category, imagined by the pushing activity or the fetching activity or by a meta-activity. In the case of the latter, the development of migratory competence contributes to a discursive and/or non-discursive unifying totality that is either projected behind the plane of human activity (naïve realism) or constructed in front of it.

I want to refer to the alliance-specific nature of all activity as *disciplinarity* and to claim that the abstracted practices that constitute the disciplinarity of school mathematics are, for the most part, substantially detached from other disciplinarities, both in the school and beyond. This does not entail that we cannot constitute continuities between school mathematics, university mathematics, school and university physics, domestic practices and so on, but that such continuities as we can identify are likely to be rendered differently in each, as I have illustrated and argued above. Thus, we do not find repetitions of elements of the mathematics syllabus on the physics syllabus or *vice versa*—as a perusal of the Swedish school syllabuses will illustrate (Swedish National Agency for Education, 2008)—even though they may be thought to be closely related subjects. This is not surprising; the training and appointment of teachers—at least, in high school—the school timetable and national assessments and international tests (for example, Pisa and TIMSS) are generally organised on the basis of what Bernstein (1977, 2000) refers to as a collection code, the component fields of which must deploy disciplinarity strategies to constitute public singularities.[6] General curriculum principles and policy must be constituted at a higher level of analysis by a meta-activity or activities as I have suggested in relation to transferrable knowledge and skills. Thus the curriculum is constituted as a collection code via disciplinarity strategies; meta-activity must, insofar as it casts a principling gaze on multiple disciplinarities, recontextualise the collection code as something resembling Bernstein's integrated code. The two levels collapse in the form of a substantive integrated code only in the absence of strategies of disciplinarity (which seems empirically unlikely).[7]

The effect of disciplinarity strategies in constituting the school curriculum as a collection of self-referential esoteric domains and—at least in mathematics—a collection of mythologised, public domain practices is curricular solipsism. This being the case, it is unclear how the continued status of mathematics and other members of the collection as compulsory curriculum subjects can be justified. Because of the importance of the public domain as the apparent guarantor of utility in mathematics, this subject, in particular, is potentially dangerous as the brief discussion of the mathematising of traffic stops demonstrates. Elsewhere (Dowling, 1998, 2009) I have referred to this danger as the myth of participation: that mathematics provides a necessary supplement to the practice in non-mathematical activities. In Dowling (2007, also 2009) I have made a similar argument in

6 Bernstein refers to these as boundary maintaining strategies. My approach, however, is relational, so the concept of 'boundary' is unhelpful.

7 There is an important issue here that I shall not pursue further in the main text. There is a consistent hierarchy that runs through the whole of Bernstein's work that privileges the former in each of the following pairs: elaborated/restricted speech code; integrated/collection curriculum code; vertical/horizontal discourse; hierarchical/horizontal knowledge structure. In each case, the privileged category is constituted only via the objectification of the subordinate category, which is to say, through the actions of a meta-activity. The same is clearly true of Luria's theoretical and participative thinking that was the basis for Bernstein's oppositions. Bernstein's apparent failure to recognise this is consistent with his more general lack of attention to the movement between levels of analysis in switching between classification and framing (see Dowling, 2009, Dowling & Chung, 2009, and particularly Chung, 2009).

respect of the construction of what I referred to as mathematicoscience in TIMSS test items as privileging rational argument (mathematics) and objectivity (science) as, in effect, both necessary and sufficient conditions for the enactment of public decision-making and problem-solving. Of course, real decisions are not generally made nor real problems solved in public, but in private, where the discourse is, we might think, more likely to be irrational and prejudiced.

Distribution and the new massification

The second dimension of Bernstein's pedagogic device is its distribution rules. Now, in my earlier analysis of school mathematics textbooks (Dowling, 1991a, 1991b, 1995, 1996, 1998) I argued that school mathematics—as constituted in these books—served, in effect, as a translation device for converting socioeconomic class into mathematical 'ability' as 'objective' properties of students. It does this by realising socioeconomic class characteristics (such as occupational difference) in curricular tracks that are differentiated in terms of 'ability'. Further, by apprenticing high socioeconomic class/'ability' students to esoteric domain mathematics and low socioeconomic class/'ability' students to the mythical collection of practices that constitutes the public domain, school mathematics provides a career path for the former, but not for the latter. Essentially, the curriculum for high 'ability' students is about mathematics, whilst the curriculum for low 'ability' students presents mythologised versions of the students' own lives.

The introduction of the concept of disciplinarity, however, suggests that I should revise my description. I have now described the esoteric domain—and I shall have more to say about this domain in the next section—as constituting a self-referential region of practice, an element of a collection of such self-referential regions of practice that comprise the school curriculum. Students—the high socioeconomic class/'ability' ones—apprenticed to this domain are also being admitted to a mythologised practice; yes, they have a career within school mathematics, but this is a dead end job! It will be pointed out, of course, that entry into the esoteric domain of school disciplines—in contrast to restriction to the public domain collection—gives potential access to symbolic capital in the form of qualifications and that these can be 'exchanged' for further symbolic capital (university entrance) or direct economic capital through higher paid employment. However, what I want to term *new massification* strategies in education entail that erstwhile elite educational performances are now becoming much more widely distributed. Such performances are evidenced in the UK, for example, in terms of the increasing proportions of 16-year-olds obtaining grade A or A* at GCSE—now 20% according to *The Guardian* (27th August 2009), the increasing proportion of A grades being awarded at A-level year-on-year for the past 27 years reaching 26.7% in 2009, with an overall pass-rate of 97.5% (*The Guardian*, 20th August 2009), the participation rate in Higher Education for males, in 2007-8 was 38% and for females, 49% (DIUS).[8] Ultimately, the new massification strategies tend to foreground one-dimensional abstractions, numerical performances in respect of certification, university registration, national assessments, international tests and so forth. These simple statistics are recruited as metrics for institutional and governmental performance (see, for example, Smithers, 2008). Whether or not these developments have led to a lowering of standards, the new massification of elite performances is certainly reducing their value as symbolic capital as schooling performances are increasingly based upon criterion rather than norm referencing

8 www.dcsf.gov.uk/rsgateway/DB/SFR/s000839.

and schooling assessments increasingly resemble driving tests: all might reasonably be expected to pass (eventually) or, as Melanie Phillips (1998) put it, *All Shall Have Prizes*. Governments can use metrics as evidence of their achievements towards this goal, setting measurable targets in the same way as the British government has set targets for the number of medals to be won at the 2012 Olympic Games; but then, the Olympic Games are exclusively for elite performers. The prevalence of strategies of disciplinarity presents a valid case for abandoning mathematics as a compulsory school subject—at least in secondary schooling: the prevalence of metrics in new massification strategies sentences children to twelve years at hard labour in service, not of themselves, but 'democracy'.

Evaluation and conceptualisation

The third dimension of the pedagogic device is its rules of evaluation. We don't need the introduction of an arcane social organ to tell us that evaluation, in one form or another, is implicated in most if not all of what we do. The crucial issue here, however, concerns what is being evaluated, how, and to what effect. Pertinent to this is an episode reported by Mike Cooley from his research conducted in the aerospace industry.[9]

> At one aircraft company they engaged a team of four mathematicians, all of PhD level, to attempt to define in a programme a method of drawing the afterburner of a large jet engine. This was an extremely complex shape, which they attempted to define by using Coon's Patch Surface Definitions. They spent some two years dealing with this problem and could not find a satisfactory solution. When, however, they went to the experimental workshop of the aircraft factory, they found that a skilled sheet metal worker, together with a draughtsman had actually succeeded in drawing and making one of these. One of the mathematicians observed: 'They may have succeeded in making it but they didn't understand how they did it.' (Cooley, 1985; p. 171)

Which team was the more highly appreciated by the management, I wonder.

Before discussing Cooley's story, I want to introduce a schema relating to the contexts of pedagogic transmission.[10] Firstly, transmission may be institutionalised within the context of the production and/or elaboration of the practice. This mode characterises the 'legitimate peripheral participation' of Lave and Wenger (1991) (though not necessarily all of their examples) and also what might be described as traditional apprenticeships (see Coy, 1989a). The craft apprentice—the apprentice Tugen blacksmith, for example (Coy, 1989b), learns his (sic) craft in the forge, alongside the master. Alternatively, transmission strategies may be elaborated by relayers of the practice, who mediate between the mythologised practice (the 'knowledge' of the expert practitioner, experienced member, etc). In this mode, pedagogic theory will tend to take the foreground and the practice to be transmitted will be constituted as a curriculum. This is clearly the mode that is prevalent in schooling, where the emphasis is on the transmission of the mathematical expertise, but not the teaching expertise, of the teacher. On the other hand, if schooling itself is the practice to be reproduced, then it may be more appropriate to think of transmission strategies that are directed at the apprenticing of the newcomer into the community of school students, or school teachers, and so forth, in unmediated mode.

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9 I have used this story many times before (see, for example, Dowling, 2004), principally for its pedagogic value, though not always in the way that I am using it here.

10 I make no apologies for the use of the term, transmission, here. Social and cultural transmission or reproduction may not (certainly does not) exhaust the intentions or consequences of pedagogy, but it is a central aspect of formal schooling and crucial to the concerns of this paper.

The second dimension of transmission strategy can be introduced by reflecting on two different examples of craft apprenticeship. The first is the apprenticeship of Japanese mingei folk potters, described by Singleton (1989). This looks very much like legitimate peripheral participation. The initial part of the apprenticeship involves minimum risk labouring work and observation around the factory. When the apprentice is permitted to work at the wheel, they are told that they must first make ten thousand sake cups. For the most part, the apprentice's products are thrown, unfired, into the clay bin for recycling until, eventually, the cups are rated as satisfactory and are sold in the shop—without the potter's mark—as seconds. Here, the apprentice as acquirer is relatively untheorised; their competence will (or may not) develop in time. Rather, the emphasis in this mode is the production of adequate products, which is to say, on performance, rather than on competence.

The apprenticeship of the mediaeval scribe seems to operate differently. In a 'school for scribes' described by Aliza Cohen-Mushlin (2008), the master (sic) scribe would pen a few lines as an exemplar and then the pupil would take over. When the pupil's performance was inadequate, the master would produce another exemplar. If the pupil progressed, they would be permitted to advance to more challenging tasks, such as rubrication and eventually take on the role of master. Here, there is clearly a sense of what is an adequate performance. However, a work completed in this mode will contain instances of both adequate and inadequate performances as the pupils' work would not be scrapped; parchment would have been too costly for this and, presumably, such a procedure would have introduced too great a delay into book production. This leaves the emphasis of the apprenticeship far more on the competence of the apprentice than on the quality of the final product, which is always going to be imperfect. The distinction between this mode and that of the pottery apprentice is, as is generally the case, one of emphasis, almost nuance, perhaps, but nevertheless discernible. Pedagogic theory—or what we can know of it—is light, in the scriptorium, seemingly confined to the provision of exemplars, imitation, and correction, nevertheless it is there.

	Transmitter Focus	
Mediation	Competence	Performance
Unmediated	*delegating*	*apprenticing*
Mediated	*teaching*	*instructing*

Figure 2. Transmission Strategies

The cartesian product of the two dimensions of transmission strategy gives rise to the relational space shown in Figure 2. Two of these strategy modes, teaching and apprenticing, are quite familiar and commonly opposed as, indeed, they are here, though in what I think is an original way. The commodity outputs of schooling might be said to be various forms of credentials that attest to competence. We might say, then, that the tools of the school are the curriculum and assessment protocols and its raw materials are its students. The performances produced by the students are generally of little importance once they have been assessed. The commodity outputs of factories are the performances of their staff, so the situation is the reverse of that of the school and it is unsurprising that we find novices confined to low-risk (and probably low paid), peripheral activities until their performances are judged to be satisfactory.

The leading diagonal of Figure 2 opposes delegating and instructing. The mode exhibited in Cohen-Mushlin's scriptorium has been labelled, delegation, which is here being understood as a strategy of transmission rather than a strategy of management (though one might presume that the latter generally entails the former). Here, unlike the situation in teaching, master and pupil performances are the principal products of the activity, yet the emphasis is on the development of a community of competent practitioners, rather than or, at least, as well as, on the quality of any these products. I have no other empirical instances of this mode, though one might look to amateur, hobbyist activities. I have also encountered the sharing of repertoires of skills within informal (ie based in the public house) communities of jobbing builders and delegation might be an appropriate description of transmission strategy here. Consultancy work (the consultant being in the position of the transmitter) might be explored for evidence of this mode as might activities around succession planning in institutions.

Instruction is also frequently opposed to teaching and it constitutes the form of mediated transmission strategy that does not involve any developed pedagogic theory. I suppose sets of instructions accompanying consumer goods would frequently be described in this way. Not all instruction books are exhaustively described like this, however; the users manuals accompanying the professional grade cameras that I use tend to attempt to cater for incompetent users by including some teaching on the basic principles of photography and, in this respect the manuals differ from some of the reviews on websites concerned with photography.

To revisit the Cooley's afterburner episode, it would appear that the mathematician is privileging the evaluation of competence over performance. However, competence, in the form of 'understanding', is being measured in terms of the presumed need to devise an explicit, mathematical formulation of the problem. We might suppose—Cooley provides no evidence here—that the draughtsman and toolmaker 'understood' the problem in relation to its formulation according to different technologies that prioritised manual—what I refer to as low discursive saturation (DS^-), rather than intellectual or high discursive saturation (DS^+) practices and that they would have evaluated their activity—at least on this occasion—in terms of performance rather than competence. The social class implications are clear. Here, however, it is also interesting to note that, whilst (if my supposition is correct) the manual workers would have evaluated their performance on the basis of technologies and an apparently successful prototype product that are directly and routinely implicated in the activity of production, the intellectual worker appears to have been introducing an evaluative apparatus—mathematics—that might be more readily associated with mediated transmission and/or with a different field of production—in the university: it seems to have been relevant that all four mathematicians were 'of PhD level'.

The aerospace example is not, of course, an incidence of transmission, but it does involve evaluation and, in this respect, the referential objects supposedly used by the manual workers seem more at home in the context of production than do those of the mathematicians. I want to propose that both transmission in the context of production—delegation or apprenticeship—and transmission focusing on performance—apprenticeship or instruction—will tend to privilege the objects of production as the principle (which is not necessarily to say exclusive) referential objects for evaluation. This is because all three strategies must emphasise production as the main task in hand, closing down on opportunities for non-productive tasks. Uniquely, mediated, competence-oriented transmission—teaching—opens up a space for dedicated pedagogic action, because performances *per se* are arbitrary and ephemeral. Furthermore, because competence is postulated rather than directly visible, pedagogic action directed at its evaluation may be described as *forensic*, which is to say, directed at revealing things as they are (Dowling, 2009), in this case, 'things' referring to competence as a putatively objective (though potentially changeable) property of the evaluee. In the field of educational studies an assessment industry has developed. Forensic evaluation is theorised and standardised tests are constructed and deployed nationally and internationally. As I have noted in the previous section, performances on such tests are recruited as metrics in demonstrating or challenging the success of government education policy and so forth so that performance as such is important. However, these are not production competences; in and of themselves, they do not matter other than insofar as they are interpreted as forensic indicators of underlying competences.

In mathematics education—and in other subjects in the curriculum collection—competence is often described as 'understanding', as in the Cooley episode. Here is Jeff Vass—a sociologist and former researcher in mathematics education who now works in social theory:

> On leaving ed research I had got to the point where I thought it doesn't matter what is taught in maths. maths ed seemed to me to be full of spurious, hybrid psychological speculation justifying this or that teaching method. things that i thought might be useful, or have been useful to me, (like knowing by rote ones multiplication tables) were regarded with horror by people i met in education. They said children need to 'understand number' - i said this had never occured to me when learning tables by rote, and while contemplating 'what is number' might be something i could see myself doing at some point i could get along without understanding anything at all when converting fahrenheit to centigrade. didn't go down well. (Personal email)

I want to refer to this emphasis on competence or understanding as *conceptualisation* and I want to claim—and I suspect I will find few challenges in the field of mathematics education here—that this is a central strategy in the teaching mode of transmission. Another realisation of the conceptualisation strategy is the contention that learning mathematics is primarily concerned with the cognitive acquisition of mathematical objects, which, Raymond Duvall (2006) argues, are rather different from the objects relating to the 'other domains of scientific knowledge' (p. 107):

> From an epistemological point of view there is a basic difference between mathematics and the other domains of scientific knowledge. Mathematical objects, in contrast to phenomena of astronomy, physics, chemistry, biology, etc., are never accessible by perception or by instruments (microscopes, telescopes, measurement apparatus). The only way to have access to them and deal with them is using signs and semiotic representations. That means that we have here only a single access to the knowledge objects and not a double access, mainly non-semiotic and secondarily semiotic, as is the case in the other areas. (Duval, 2006; 107)

And further,

> Mathematics is the domain within which we find the largest range of semiotic representation systems, both those common to any kind of thinking such as natural language and those specific to mathematics such as algebraic and formal notations. And that emphasizes the crucial problem of mathematics comprehension for learners. If for any mathematical object we can use quite different kinds of semiotic representation, how can learners recognize the same represented object through semiotic representations that are produced within different representation systems?
>
> […]
>
> This functional difference between the various semiotic representation systems used in mathematics is essential because it is intrinsically connected with the way mathematical processes

> run: within a monofunctional semiotic system most processes take the form of algorithms, while within a multifunctional semiotic system the processes can never be converted into algorithms. For example, in elementary geometry, there is no algorithm for using figures in an heuristic way […] and the way a mathematical proof runs in natural language cannot be formalized but by using symbolic systems. Proofs using natural language cannot be understood by most students […]. (Duval, 2006; 108-9)

So:

1. There is no perceptual contact with mathematical objects, but there is in other activities;
2. Mathematics consists of a complexity of semiotic systems for the representation of its objects;
3. There is, in general, no unambiguous transduction between representations in different semiotic systems;
4. This generates difficulties for students of mathematics.

Duval also marks a distinction between proof and argumentation in mathematics and outside of mathematics, respectively:

> We can observe a big gap between a valid deductive reasoning using theorems and the common use of arguments. The two are quite opposite treatments, even though at a surface level the linguistic formulations seem very similar. A valid deductive reasoning runs like a verbal computation of propositions while the use of arguments in order to convince other people runs like the progressive description of a set of beliefs, facts and contradictions. Students can only understand what is a proof when they begin to differentiate these two kinds of reasoning in natural language. (Duval, 2006; 120)

Thus:

5. Even within a single semiotic system, there are (what I would call) fundamental discursive differences between mathematics and other activities.

Duval's realist methodology is problematic, for me, in two respects. Firstly, I do not want to ontologise the objects of mathematics nor, indeed, those of astronomy, physics, chemistry, biology, etc. Let me put it this way. The natural sciences—say, endocrinology—might be interpreted as coordinating theory and method, where the latter is, in part, constituted by the instrumentation that Latour and Woolgar (1979) referred to as inscription devices and the principles of deployment of this instrumentation. The objects of endocrinological activity, then, are, like those of any other activity, including mathematics, to be taken to be constructed within the activity rather than noumenal objects sending messages to the endocrinologist. This, incidentally, is not an anti-realist claim, in a naïve sense, merely a form of a-realism that places its interest in the specific constructions of human activity rather than on faith in the metaphysical.

Secondly, for my purposes I do not find it helpful to essentialise semiotic systems—language, visuals, …—or even registers—algebraic and other forms of discursive representation—nor to consider the phases or aspects of signification; given a mathematical context, I cannot hear the word 'circle' or see a visual representation of a circle without the one calling up the other (although the specific visual may depend upon the context). Rather, I want to focus my attention on strategies that structure the esoteric domain, here of school mathematics. So, instead of taking mathematics to comprise a range of semiotic systems, I suggest that it is more appropriate to say that it is characterised by a mixture of strategies that includes: i) discursive definitions, principles, theorems and so forth; ii) visual exemplars, most obviously in the area of geometry; iii) formal nomenclatures (the decimal representation of number, for example) and heuristics; and iv) instrumentation (calculators, computers, geometric instruments, and so forth). Now this empirically based list can be reconceptualised as a complex apparatus that exhibits variation in semiotic mode—discursive (available within language)/non-discursive (not available within language)—and action—interpretive/procedural. This gives rise to the schema in Figure 3.

	Semiotic Mode	
Mode of Action	Discursive	Non-Discursive
Interpretive	*theorem*	*template*
Procedural	*procedure*	*operational matrix*

Figure 3. Modality of Esoteric Domain Strategy

Now, quite clearly, the categories constituted in Figure 3 refer to general/generalisable aspects of the esoteric domain; a template would be of little use if it constituted a unique instance. These general modes are then repeated as local instances, giving rise to a three-dimensional schema, represented in Figure 4.

I'll take an example that I've modified from Duval's paper to illustrate the schema; this is the mathematical problem, what is the relationship between the perimeter of triangle ABC and the lengths, AE and AF in Figure 5. The verbal statement of the problem is a localising of theorem, that is, an enunciation; the grammatical issue that it is in the form of a question rather than a statement is not relevant here. Figure 5 itself is a graph, so a relevant procedure would be, identify a suitable template. This has been done in Figure 6.

	Semiotic Mode	
Mode of General Action	Discursive	Non-Discursive
Interpretive	*theorem*	*template*
Procedural	*procedure*	*operational matrix*
Mode of Local Action		
Interpretive	*enunciation*	*graph*
Procedural	*protocol*	*operation*

Figure 4. Modality of General and Local Esoteric Domain Apparatus

The template serves (in my reading) to articulate theorem and operational matrix as follows (I'll restrict myself to plane geometry):

Theorem

1. A circle is the set of points that are equidistant from a fixed point that is its centre;
2. There are two tangents to a circle from any point outside the circle;
3. These tangents are of equal length;
4. The tangents are perpendicular to the radius of the circle at the point at which they touch the circle;
5. The two tangents to a circle from a point outside of the circle, the line joining this point with the centre of the circle, and the radii of the circle at the points at which the tangents touch the circle form two congruent, right-angled triangles

Operational matrix

6. Circles and line segments may be constructed by straight edge and compasses or using draw software on a computer.

A simple solution to the problem lies in recognising the template, Figure 6, in Figure 5; it can be seen to occur three times, as shown in Figure 7.

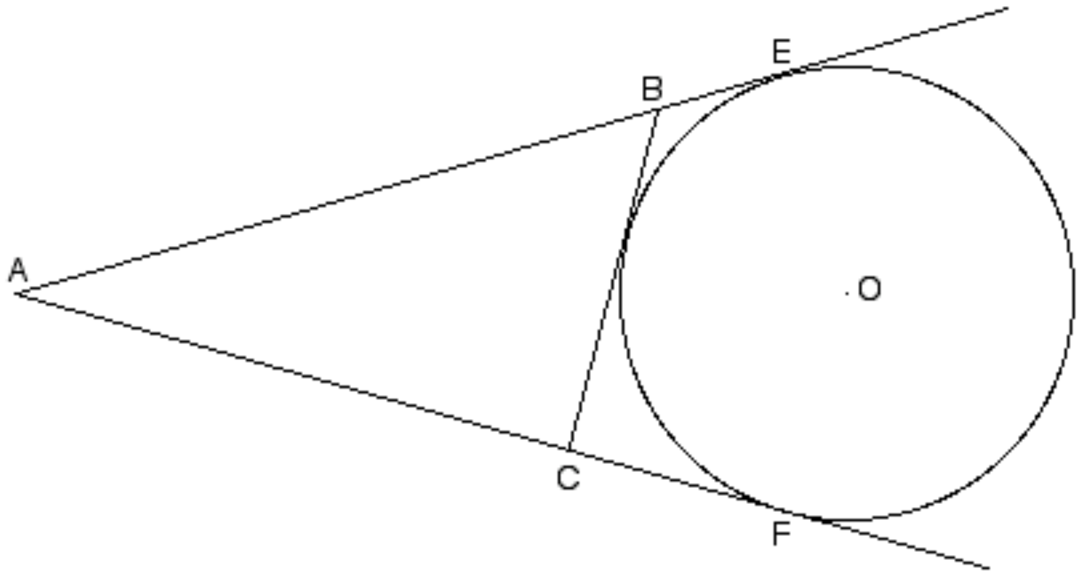

Figure 5. A Geometrical Graph

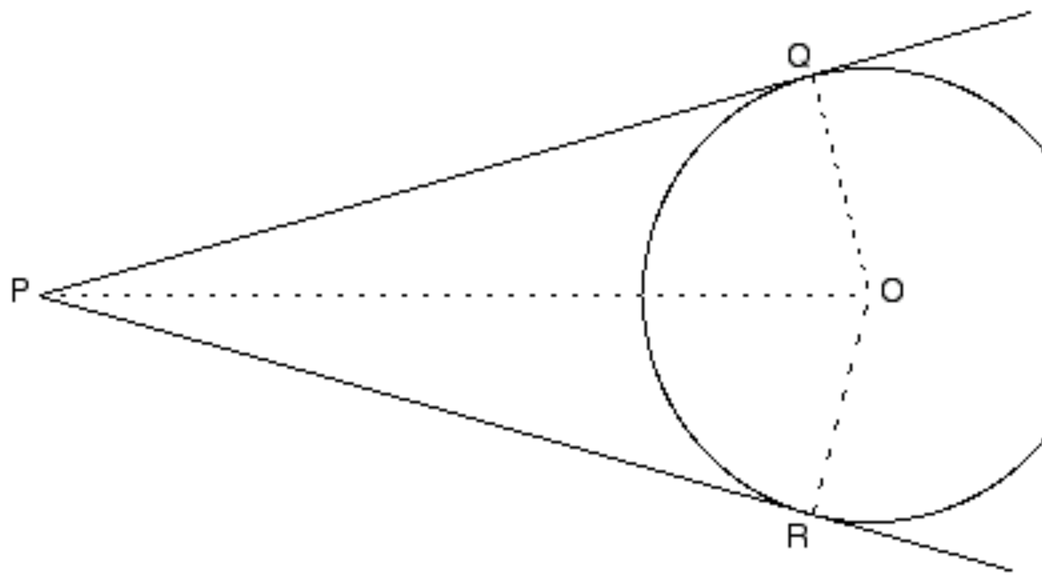

Figure 6. A Visual Template

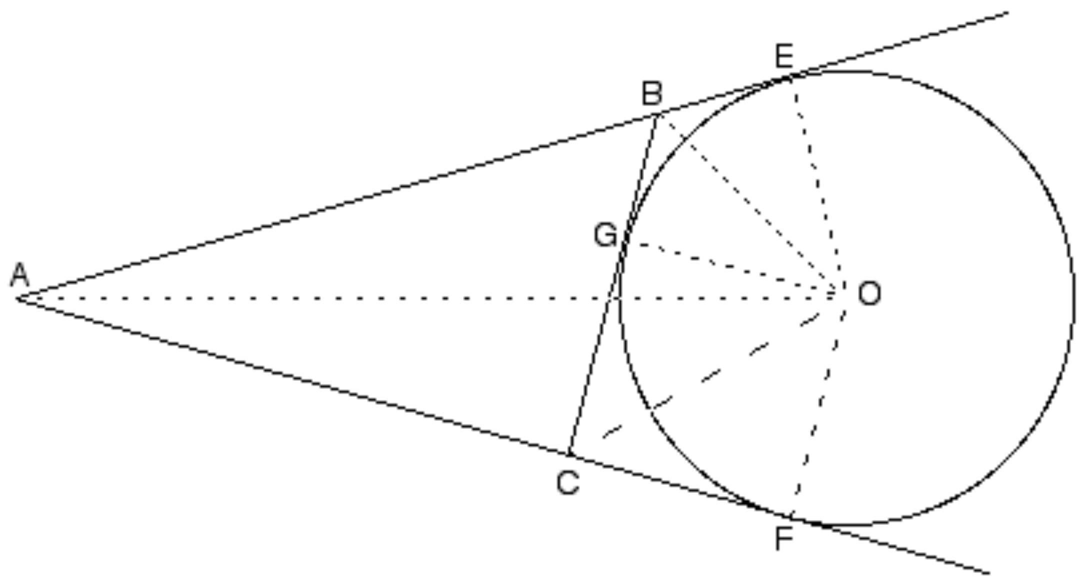

Figure 7. Realisations of the Template in the Original Graph

Figure 7 reveals equivalents to the kite shape, PQOR (Figure 6) as AEOF, BEOG and CGOF, so we know that BE = BG and CG = CF and so we can conclude with the solution: the perimeter ABC = AE + AF. This has arisen out of the selective articulation of the original enunciation and graph with the procedure and template and its associated theorem. Presumably, the problem might have been produced entirely as an enunciation; I will not attempt this here, but I suspect that the result would be quite tortuous; the visual texts enable us to recollect and organise the esoteric domain apparatus rather more efficiently, at least, than would be the case without them. They work very effectively here, and in school mathematics more generally, because the template, Figure 6, is strongly institutionalised within and by the practice as are other geometrical templates (images of standard geometrical forms and relationships; a pair of parallel lines traversed by a third line being another example).

Now I've referred to the discursive elements of problem and solution as enunciation, which is to say, local rather than general discourse (theorem). However, the lack of specific measurements (for the lengths of line segments or the magnitude of angles) does tend to generalise the figure, so there is a sense in which the solution is constituted by both enunciation and theorem strategies. Alternative solutions to that offered by the argument presented here might involve operational matrix/operation strategies. For example, it is clearly possible to measure the lengths directly from the graph and draw inferences from the results. This may be deterred in practice by another enunciation to the effect that the graph is not drawn to scale, but the operational solution would clearly eliminate theorem from its strategy.

In the consideration of number, we might consider that it is more helpful to think of, say, 351 as a text rather than as a sign.[11] As a spoken text, we would say 'three-hundred-and-fifty-one', marking out the place value system by the addition of words ('hundred') and inflections (five becomes fifty). This simple enunciation is associated with procedures that have to do with arithmetic. However, 351 is also a graph in the sense that the signification of each digit (digits are signs) is given by its spatial position relative to the others. A relevant operational matrix might be a spike abacus (there is no other obvious (and certainly no other obviously simple) way to move from the local instance, 351, to a more general text. Setting up the abacus as 351 is an operation. The abacus provides a simple technology for addition and subtraction within the positive integers, but is less successful (which is to say, rather complicated) for multiplication and division. We are left, then, without a non-discursive strategy for these latter operations; all we have are procedures. Clearly, we can produce alternative graphs for multiplication, rectangular arrays of dots, for example, transducing one graph, 352 x 792, into another—a rectangular array of 792, rows each containing 352 dots. Alternatively, we can produce a procedure for multiplication in columns or we might attempt to use a number line for all four operations. As Duval points out, there is clearly scope for considerable confusion.

Duval also emphasises that there are, in general, no unambiguous transductions between semiotic registers. This translates into my schema as the principle that, whilst there may be legitimate and illegitimate specific articulations between modes, the possible legitimate articulations may outnumber those that are necessary for the particular purpose at hand. In the geometry case above, for example, we do not need to know that the angles AEO and AFO are right angles, nor how the diagram was constructed. This entails that there is a problem of selection from the possible articulations, but the localisation that the template achieves clearly reduces this. For a discursive example, we might note that $2x + 3 = 0$, cannot be unambiguously transformed, but its recognition as a particular category of mathematical problem (procedure) is likely to narrow things down. We would, for example, expect most students making this recognition to compute $2x = -3$ and then $x = -1.5$ and this is the key: becoming a successful school mathematician entails the acquisition of a complex apparatus of interpretation and procedure. The solution of a problem is then a matter of selecting one or more suitable interpretation or interpretations and one or more procedure or procedures. The mathematical apparatus also constitutes the basis for the mathematical gaze that constructs the descriptive, public and expressive domains of action. To the extent that typical problem

[11] See Dowling (2009) for a discussion of the distinction between text and sign.

texts are available in these domains, one might suppose that facility in problem solving outside of the esoteric domain may also be acquired in a similar fashion to esoteric domain problem solving facilities. In school mathematics we certainly find expressive domain pedagogic graphs, for example, drawings of fractions as shaded parts of geometrical figures, equations as balances, and so forth.

As I have suggested, it may be possible to reduce the whole of school mathematics to theorem and enunciation strategies. It may further be the case that the resulting discourse would be characterised as DS^+ and highly coherent, which is to say that it would construct its objects in a consistent way. But it would not be teachable; we can hardly introduce the Peano axioms before the number lines that adorn the walls of elementary school classrooms. To render it teachable, we, in effect, pedagogise it. In order to achieve the discourse, the practice has to diversify its apparatus as in Figure 4 and weaken the institutionalisation of its significations in extending beyond the esoteric domain. The latter also serves as a marketing device in enabling school mathematics to be presented as something other than a closed mystery.

Now my interpretation of Duval's argument is that the work of signification in school mathematics is rendered complex because the objects of mathematics are signified in diverse semiotic registers between which there are no unambiguous transductions, so an essential aspect of the work of mathematics education lies in the coordination of these registers. This entails, of course, coordination around the objects that they signify. However, it may be that the basis of the problem lies not in a lack of coordination, but in the perceived necessity of coordination that itself derives from the ontologising of mathematical objects, conceptualisation. Such ontologising is facilitated in the sciences, according to Duval, by the fact that we have non-semiotic, perceptual access to the objects of the sciences albeit often mediated by technology. But, of course, we do not have access to anything at all that is not semiotically mediated, though the successfully marketed articulation of discursive and non-discursive apparatus in the natural sciences may have misled us into believing that we do.

On the other hand, school science does often seem to be very 'thingy'. We arrange 'experiments' to find out or confirm or sharpen up our knowledge about 'things'. We can separate the components of a mixture of sand, wood, iron, and salt by taking advantage of what we know about them (sand sinks in water, wood floats, salt dissolves and iron is attracted to a magnet); we can make graphs to predict the extension of a spring under different loads (and this is how a spring balance works); we can cut up a mouse to see where the various bits are; and so forth. The objects of science are, of course, not, generally, these things, but the objects constructed in science discourse: specific gravity; solubility; magnetisability; elasticity; anatomy (and its components); and so forth. This language is available to describe these things and other things like them. We do not—at least not below high school—very often go much beyond describing. We often do the same kind of exercise in mathematics, but the contexts are often rather different. Firstly, the things in the mathematics class are often presented, at least initially, in public domain terms; they are presented as if they are the way they are in our daily lives; let's think about shopping, for the time being. This, of course, is part of the point of mathematics as it is sold in the mathematics classroom: to enable us to engage more effectively in everyday situations (the myth of participation). However, because we are to constitute the things in mathematical discourse and not within the everyday practices from which they are taken, what students see is a contortion of their own lives. Science, on the other hand, is not generally claiming to assist in managing one's daily lives. The things in science are, right from the beginning, placed in an unusual context and often in an unusual room—the laboratory. 'Suppose you (we) have a mixture of sand, wood shavings, salt and iron filings (not bits of a bicycle or car engine) and we want to separate out the various components; what can we do?' As with mathematics, there is no unambiguous transduction from the enunciation and its associate graph (the beaker containing the mixture) and no necessary separation between scientific discourse and everyday practice: we're not interested in the molecular structure of the salt nor its taste. School maths seems to be telling you lies about your own life; school science seems to be telling you new stuff about things that you're kind of familiar with, but perhaps have not really thought about.

School mathematics also has its 'laboratories', of course (generally not specially designed rooms, though). Here, we construct geometrical figures, play with abacuses and blocks of wood and hoops and chalk circles and so on. This must seem an arcane game. It's not immediately obvious why we should be interested in such things, but, even if we are, mathematics is not really about them at all; they seem to be pointing at something else. Whilst the entry to school science seems to be via the descriptive domain, the entry to school mathematics is often via the expressive. In formal terms, both school mathematics and schools science technologies construct their objects; school science defers entry into its discourse, perhaps, whilst school mathematics will not. This is not a philosophical or perhaps even a psychological problem, it's a pedagogic problem.

In addressing the pedagogic problem, one is led to ask, if scientific discourse is dispensable, at least in the earlier phases of school, might this not also be the case for mathematical discourse. Indeed, whether or not a fully principled, DS^+ version of school mathematics is possible, the integrating discourse would have to be constructed by meta-activity. At any point within school mathematics—which incorporates templates, procedures and operational matrices as well as discourse—the impossibility of general, unambiguous translation or transduction between school mathematical texts constitutes aporias and I want to suggest that it is the resolution of these aporias that motivates conceptualisation. I want to speculate that this is because mathematical integrating discourse cannot abide a vacuum. This is why Gödel's inconsistency theorem is so profoundly disturbing; this is why Foucault is justified in describing mathematics as 'the only discursive practice to have crossed at one and the same time the thresholds of positivity, epistemologization, scientificity, and formalization' (1972; p. 188). Duvall's distinction between mathematics and 'other domains of scientific knowledge' has some validity after all. However, the difference is to be sought, not in ontology, but in the opposing strategies relating to the empirical that are prevalent within the respective activities: science must confront an empirical universe and must, therefore, be perpetually incomplete; mathematics must quickly discard the potentially corrosive empirical world even though its temporary introduction may be necessary for pedagogic reasons.

Conceptualisation, then, is a strategy that produces mythical mathematical objects and directs pedagogic action to their transmission. An alternative might be to consider rolling back on the conceptual approach to mathematics education that has held sway for the past sixty years or so and focus, instead, on the study of 'things'. I am suggesting that we refrain from erecting an arcane and only putatively totalising structure and mythical mathematical objects as mathematical discourse and concentrate, instead, on the fostering of, shall we say, *petits reçits*; procedure, templates and operational matrix strategies that are recruited within the study of 'things'. What's the best way to learn the functional use of a foreign language: to attempt to acquire generative grammatical discourse; or to acquire useable chunks? To the extent that grammar is never generative, but only at best interrogative, then the answer would seem to be the second alternative; grammar can, if we absolutely must have it, come later.

A new sociology of knowledge and curriculum reform

The new sociology of knowledge, part of which I have presented here, is called *Social Activity Method* (SAM). It is explored in greater depth and breadth in Dowling (2009), though the schemas in Figures 2, 3 and 4 have been developed since the earlier work went to press. I have emphasised three aspects of SAM that mark it out from other sociologies of knowledge and, in particular, from the sociology of Basil Bernstein, which has been particularly influential in the sociology of education. Firstly, the central proposition that guides analysis is that the sociocultural space is animated by strategic, autopoietic action directed at the formation, maintenance and destabilising of alliances and oppositions, the visibility of which is emergent upon the totality of such action. The schemas that are presented in this paper (see Figures 1, 2, 3 and 4) and others[12] emerge from the transaction of the central proposition with the empirical world, which is to say, with the world not already 'consumed' by SAM. Secondly, if we think of the empirical sociocultural world as being available as an unmotivated collection of texts and settings, then its transactions with SAM is constituted as a meta-activity that integrates small parts of this collection. The integrating metadiscourse is being conceived as what I refer to as *constructive description*; it is an artefact of the analysis that does not claim to be accessing motives that lie behind the empirical collection. Rather, the metadiscourse presented here may be thought of as standing in front of its object texts. This is not forensics; its evaluation is not to be assessed in relation to truth, but rather in terms of its pragmatic value in organising a disordered collection. The cohrence of the metadiscourse is not irrelevant, here. However, I (Dowling, 2009, Dowling & Brown, 2010) maintain that an undue level of coherence—closure—is ultimately unhelpful in that a fully closed discourse can see only itself and cannot learn; it becomes sclerotic and necrotises the empirical. Thirdly, the method pushes analysis to the point of binary categories of strategy and, most commonly, considers the spaces opened up by taking the Cartesian product of two such categories. A relational space produced in this way is clearly logically complete. However, texts and settings are not totalised by these spaces. Firstly, whilst a particular strategy may dominate in a given text or setting, the expectation is that most texts/settings will be describable in terms of more than one, so that a particular space will provide the basis for mapping regions and trajectories within the text/strategy and the results may be aggregated to produce descriptions at higher levels of analysis. Secondly, a given space provides an analytic schema in terms of, generally, only two variables; further spaces may be deployed or generated to produce more complex pictures of the text/setting.

I have chosen, in this paper, to depart from Bernstein's construct, the pedagogic device and its three sets of rules. These rules and my departures are summarised in Figure 8. I have also used Bernstein's distinction between collection and integrated curriculum codes as a point of departure. In Bernstein's scheme, these are alternative forms of curriculum organisation. I have argued here that integrating principles must be generated within a metadiscourse.[13] I should, perhaps, reformulate this as: push strategies recontextualise their

[12] There are over 200 specialist terms relating to SAM in the glossary of Dowling (2009) and thirty or forty more have been generated since this work went to press.

[13] If we accept that there can be no absolute primitive principles—all principles must be interpreted in terms of prior principles in an infinite regress—then integrating curricular principles can be achieved only in a

objects as integrated codes; fetch strategies recontextualise their objects as collection codes; a metadiscourse is, of course, a push strategy. We can go further and suggest that the integrated code constituted by push strategies might be constituted as the hegemonic imposition of integration on an inevitably unintegrated activity. This is precisely the offence of the mathematician in Mike Cooley's anecdote. This is precisely the offence of governmental new massification strategies in constructing a single, privileged career trajectory for all school students. This is precisely the offence of Eric Gutstein in rendering illegal traffic stops made by Illinois police. This is precisely the problem with formal schooling.

Pedagogic Device Rules	Departure	Implications
Recontextualising	*disciplinarity*	i) school curriculum as collection of self-referential disciplines; ii) domains of action schema (Figure 1); iii) school mathematics recontextualises practices originating in other disciplines (esoteric domain provides integrating schemes for public domain collection); iv) push and fetch recontextualising between members of collection; v) integrating meta-activities; vi) myth of participation.
Distribution	*new massification*	i) school mathematics distributes public domain to low class/ability students and esoteric domain to high class/ability students (both mythical practices); ii) symbolic capital decreasing in value as access to previously elite performances expands.
Evaluation	*conceptualisation*	i) *teaching* transmission strategy opens space for forensic assessment; ii) multimodal esoteric domain apparatus exhibits aporias; iii) metadiscourse mythologises mathematical objects and 'understanding'.

Figure 8. Departures from Pedagogic Device

The solution is to redesign the curriculum around fetch strategies by freeing it from the stranglehold of disciplinarity, new massification and conceptualisation strategies. This is not the place to develop a complete proposal for a new curriculum, which, in any event, would run the risk of simply replacing one set of integrating strategies with another. However, if we start from the proposition that schooling—and this certainly extends to include university undergraduate programmes—might be re-directed to serve as an introduction to the diversity of legitimate activities in society (ultimately understood globally), then this has to be achieved other than through the oversimplifications and distortions of integrating

metadiscourse, because a curriculum is, at best, a sequence with an arbitrary starting point, which, itself, must introduce aporias so as to constitute the curriculum as a collection. In practice, the school mathematics curriculum is constructed as a collection of topics and activities that do not form a single sequence.

disciplinarities. Academic research is one collection of such activities, of course, and these have traditionally been the main referents of a number of school subjects.[14] Taking science, as an example, here is the introduction to science studies, summarising its 'aims':

> The natural sciences have developed as a result of Man's [sic] need to find answers to those issues concerning his existence, life and forms of life, our role in nature and the universe. The natural sciences are thus a central part of the Western cultural tradition. The natural sciences can both stimulate Man's fascination and curiosity in nature and make it understandable. Natural science studies satisfy the desire to explore nature and provide scope for the joy of discovery. The aim of science studies is to make the results and working methods of science accessible. The education contributes to society's efforts to create sustainable development and develop concern for nature and Man. At the same time the education aims at an approach to the development of knowledge and views which resonate with the common ideals of the natural sciences and democracy on openness, respect for systematic investigation and well-founded arguments.
>
> (Swedish National Agency for Education, 2008; p. 40)

This looks rather more like a celebration of mythical science (and of the (also mythical) Western cultural tradition' and 'democracy' and, indeed, of 'Man') than an enjoining to engage in an exploration of what scientific activities actually entail. Real science is messy, unreliable, politicized—in terms of both its enactments and recruitings—and generally a very long way from the idealised scientific method that is generally expounded in schools and even on undergraduate programmes. This is not to deny, of course, that published scientific work—generally journal articles, not books—tend to recontextualise laboratory messiness as pristine structures of pure logic and objective observation, but then it's a general feature of the human condition that people do not do what they say they do.[15]

Much of the collection of human activities owes little or nothing to the disciplinarities of schooling. This range of the collection probably includes many of the domestic activities that are the targets of push strategies from school mathematics. To claim this is not to suggest that performances in these activities might not be enhanced by the recruitment of technologies from other activities, including mathematics, but that the principles of evaluation of these performances properly takes place in the context of the enactment of the activities themselves and not that of integrating activities such as school mathematics. Essentially, the kind of curriculum that I am proposing comes close to the idea of practitioner research or, more appropriately, proto-practitioner research, or even intern research. Clearly, this kind of curriculum would take much of the control away from the teacher and, indeed, away from the state and place rather more responsibility on school and non-school sites of activity and on teacher-student negotiation on matters of organisation and management.

It will be pointed out that the activities to be explored are themselves positivities constituted by strategies of disciplinarity. This is correct and, indeed consistent with my description of sociology as being concerned with strategic, autopoietic action directed at the formation, maintenance and destabilising of alliances and oppositions, the visibility of which is emergent upon the totality of such action. Furthermore, if it is believed that activities resembling current school subjects incorporate useful resources that might productively become the targets of fetch strategies, then they will need to be transmitted and this will entail the deployment of push strategies in establishing public domain portals. However, this does not entail that all school students need to acquire and embody twelve years worth of the

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14 Science, history, geography, and perhaps social studies, for example, though probably not mathematics, which—apart from the new mathematics blip—is substantially detached from research mathematics.

15 Even if only for the fact that saying what one does involves textualising it.

school mathematics collection, far less that this be attempted under the watchful eye of forensic assessment and integrating strategies of conceptualisation. Of course, moving in this direction would involve major social upheavals, including the abandoning by governments of new massification strategies and the abandoning by teachers and educationalists of strategies such as the organizing of conferences based upon school disciplinarities. As I say, as a sociologist, I am not optimistic.

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