Shall We Do Politics or Learn Some Maths Today?

Representing and Interrogating Social Inequality

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In this chapter we shall first introduce a schema that describes strategies of representation in terms of whether representation is explicit or tacit and whether it is oriented in consonance or dissonance with dominant or expected patterns, in this case of social inequality. We shall then use this schema to describe the construction of gender and social class in school textbooks, giving some attention to the contexts of their use. We shall argue that addressing social inequalities demands explicit, dissonant strategies, referred to here as interrogation. However, by reflecting on a particular critical mathematics lesson apparently interrogating racial inequality, we conclude that interrogation itself is likely to lead to misrepresentation where the mathematical activity is foregrounded and mathematics is likely to lose out where it is not. Ultimately, we may be left with the choice of whether to do politics or to teach mathematics.

Strategies of representation

On 23rd March 2010 the online version of *The Guardian* published an article about a photograph shot by Jimmy Sime some seventy three years earlier (Jack, 2010). The photograph foregrounds two boys from Harrow School, dressed in their 'Sunday best'—top hats, jackets with buttonhole flowers, wide collars and ties, waistcoats, and carrying canes. They were in town to watch the annual Eton and Harrow cricket match at Lords cricket ground. To the right of the two Harrovians—as we look at the picture—and slightly backgrounded are three local boys looking at them, apparently with some amusement. The Harrow boy in centre frame stands erect, one hand resting on his cane, the other on a stone bollard; he looks somewhat detached. The three locals seem scruffy by comparison in rather shabby jackets and trousers and their hands in their pockets. They are also there for the cricket match, but hoping to earn some money by doing minor errands for the presumably wealthy spectators. There are many ironies associated with the photograph that Ian Jack describes in his article. Perhaps most tellingly, the fates of the two groups seem to have contrasted radically with their respective starts in life. All three of the locals—from working class backgrounds—went on to have long and successful working and family lives. The Harrow boy in the foreground —whose father was a career soldier—succumbed to diphtheria whilst visiting his family in India a little more than a year after the photograph was taken; the other, the son of a stockbroker, suffered years of mental illness and died in an asylum in 1984.

Sime's photograph was originally published the day after it was taken in *The News Chronicle* under the headline 'Every picture tells a story'. Since then, the image has been used regularly in the media, generally accompanying articles calling for educational reform. Jack reports that the Eton and Harrow cricket match is nowadays a far more low key affair and the dress code is 'smart casual'. As he points out, 'if a photographer wanted to re-create Sime's picture, he might be faced with five boys dressed much the same, in jeans and brand names. Giving a superficial impression of equality, the picture would be even more of a lie than before.' (Jack, 2010; no page numbers). We might need a little more information than the imaginary photo alone would provide in order to accuse it of lying—the caption 'Harrow and local comprehensive boys outside the Lords cricket ground', perhaps—something would need to draw attention to the fact that there is some kind of differentiation going on. The original image achieves this via dress and posture, rendering explicit the representation of the familiar pattern of social class hierarchy, albeit that the story behind the photo—of course, unknown to most viewers—challenges this representation as exaggeration and irony. The imagined image and caption connotes social class, perhaps, via the differentiation of a famously named school and an anonymous school described only by a common category. This imagined image/caption, however, does not tell us who is who and so hints at, as Jack suggests, a representation of equality—they're all dressed the same—a representation that is dissonant with prior expectations, perhaps, but is hardly explicit.

Of course, both images are silent on other dimensions of social inequality; they include only white and apparently ablebodied boys who we are likely to assume (if we think about it at all) are heterosexual. These other dimensions may be connoted in our interpretations of the images, but, certainly, familiar patterns of inequality in these respects will not be challenged. An image from the *Edexcel GCSE Mathematics Foundation Book 1* (Pledger *et al*, 2006) addresses some of these dimensions visually and seems to share aspects of each of the others—the original Jimmy Sime photograph and its imagined update. The image this time is a cartoon. It shows five individuals who, according to bubblespeech, have just won a lottery: a female of colour; a white male in a wheelchair; a white female wearing glasses; a male of colour; and a second white male; all but the wheelchair-bound individual are standing.[1] This image resembles the first one discussed above in that social categories are visibly explicit and it resembles the second in that it is representing—albeit tacitly—an equality that perhaps challenges our expectations. Oddly, this presentation of equality is emphasised by the mathematical topic of the verbal text, 'equal shares': 'We are having equal shares', bubbles the wheelchair-bound individual; the text beneath the image reads, 'The key words here are **equal shares**. They tell you to divide'. (Pledger *et al*, 2006; p. 18).

In our descriptions of these images (real and imagined) we have introduced two variables. The first distinguishes between tacit or connotative representation of social inequality, on the one hand, and explicit or denotative representation, on the other. The imaginary photograph and the cartoon fall into the first category, the original photograph into the second insofar as it relates to social class and into the first in respect of other dimensions of inequality. The second variable distinguishes between representations that are consonant or dissonant with expected patterns; Sime's photograph is in the first category, the other two texts are in the second. This organisation gives rise to the strategic space in Figure 1.

[1] It might be noted, in passing, that the wheelchair looks rather like a hospital machine, suggesting, perhaps, that the disability might be only temporary.

Figure 1: Strategies of Representation

	Orientation to Pattern	
Expression	Consonance	Dissonance
Connotative (tacit)	*invisibility*	*tokenism*
Denotative (explicit)	*stereotype*	*interrogation*

Now we are referring to the categories, *invisibility*, *tokenism*, *stereotype* and *interrogation*, as strategies, which is consistent with Dowling's *Social Activity Method* or SAM (Dowling, 1998, 2009). Thus the Sime photograph is a denotative representation—which is to say that it is clearly marked out in the text—of social class hierarchy that is consonant with the familiar pattern of professional middle class/working class. On the other hand, it can only connote (by absence) other dimensions of social inequality, which thereby remain unchallenged. This image deploys a strategy of social class stereotype and of invisibility with respect to other dimensions. The imaginary update of this photograph, together with its caption deploys social class tokenism and, again, invisibility with respect to other dimensions. The maths text cartoon deploys tokenism with respect to the dimensions of social equality that it represents.

We are claiming that both of the variables here—expression and orientation to pattern—may be helpful in talking about the representation of social inequalities in all contexts, but, in particular, in school mathematics and associated practices as constituted in textbooks, in the media, in the classroom, and in research. Before moving to a consideration of agency in these contexts, we shall offer a discussion of the dimension of gender and social class in terms of the categories in Figure 1.

Texts, contexts and patriarchy

In many areas media representations of gender have changed significantly so that, for example, we no longer expect that financial reporters and experts will always be male and the most celebrated media 'mathematician' in the UK is probably Carole Vorderman, who also has an online maths school at www.themathsfactor.com/. On the other hand, there are plenty of areas in which stereotypical, patriarchal images persist. In sports presentation ceremonies, for example, the medal carriers are generally glamorous women—irrespective of the gender of the recipients—and the medal presenters are generally men (usually not at all glamorous) and it is rather sickening to see that the main image on the *Car Middle East Online* report on the Lebanon Motor Show shows a female model in a sleek little black dress posing seductively with a sleek, red and black sports car.[2] It remains the case that most of the business leaders appearing in the media are male—an invisibility strategy in terms of gender, so that women industrial leaders, when they do appear, are tokens. If this kind of difference generalises (which, of course, it may not), then the patterning of gender *may* be shifting on social class lines, which is to say (optimistically), greater equality in (certain) intellectual areas and (less so) traditional inequality in others. To the extent that this is the case, then our

[2] See www.carmiddleeast.com/article-1-1425-lebanon_motor_show_2010. Last accessed 14th April 2010.

alliance of enlightened intellectuals will generally produce an allergic reaction to expressions of gender inequality. Dowling, for example, reported this observation in 1991:

> *The Mathematical Experience* by Davis and Hersh [1981] includes sixty-six pictures of mathematicians (including one of each of the authors, on the dust jacket) precisely none of which are images of women. Furthermore, as far as I can see, there is no reference to a female anywhere in the book and the expected gender of a mathematician (and that of a mathematician's student) is quite apparent in the authors' choice of pronoun …
>
> (Dowling, 1991a; p. 3)

… which was very consistent—invisibility indeed! We are surprised that Davis and Hersh felt able to produce such a text only thirty years ago—perhaps the de-gendering of the intelligentsia proceeds at a slower pace in some areas than in others. Certainly, in 2010, *The Observer* (online edition) appeared embarrassed that 'Women are under-represented in mathematics' (Bellos, 2010; no page numbers), but managed to come up with one, Hypatia. The article (which gives two versions of her date of birth, for some reason) claims that 'her most valuable scientific legacy was her edited version of Euclid's *The Elements*' (Ibid). Euclid himself did not get into *The Observer* top 10, having apparently made way for his editor as the token female, who could—as far as we can see from the article—reproduce but not inseminate. The website, Math(blog) might have helped the author of *The Observer* article, providing a list of ten remarkable mathematicians—all women (Cangiano, 2008). This list includes Hypatia and the text informs us that she was the inventor of the hydrometer—an achievement possibly overlooked by *The Observer* author in his haste to insert a token female into his own list. The Math(blog) text moves beyond tokenism by bringing the dissonant orientation to dominant patterns of inequality into denotative expression; Math(blog) here recruits an interrogative strategy. The crucial question, to which we shall return later, is, what is being transmitted by this strategy?

Research on gender issues in school texts (there is not very much of this looking specifically at mathematics textbooks) has focused attention on revealing what we are calling here invisibility and stereotype strategies. A good deal of this research notes either the absence of female figures or pronouns. Thus, for example, Selzer (2007) notes the absence of women in the public sphere in Australian history textbooks; Stott (1990) found predominantly male pronouns in geology textbooks; Witt (1997) noticed significantly more male than female representations in reading texts and Michelle Commeyras and Donna Alvermann, in a study of then recent world history textbooks in the US noted that 'language functions in these textbooks to position women in stereotypical ways or to obfuscate the patriarchal system that accounts for women's demeaning experiences and differential treatment throughout history.' (Commeyras & Alvermann, 1996; p. 47). Some of this work reveals the relative absence of the feminine. This kind of partial visibility can be regarded as a stereotype strategy, which is made more explicit in many texts analysed in the research. Here, attention is on the differentiation of masculinity and femininity in terms of attribution binaries—strong/weak, active/passive, and so forth—or occupations—paid/domestic work, senior/junior. Thus Mikk (2002), looking at Estonian textbooks, finds women portrayed as caring housewives and men with successful work occupations. Similar differences are reported by Esen (2007) in Turkish textbooks; Sansom, in respect of Italian language textbooks, says 'The consistent linguistic, semantic and contextual representation of women in a stereotypical, sexist and limited manner perpetuates negative and restrictive perceptions in society' (Sansom, 2000; p. 7). Some of the research indicates that the picture has been changing. Jackie Lee and Peter Collins, for example, point out that whilst there had been a relative absence of feminine pronouns in earlier Australian English-language textbooks, there is a recent trend towards using gender-neutral terms, such as they, or paired pronouns, he or she. Dowling (1991a) described the move from stereotype to tokenism strategies in the development of the major UK textbook scheme produced by the School Mathematics Project (SMP).[3] We shall return to this work later in giving some consideration to agency.

Research concern with school texts often seems to presume that texts that are consonant with dominant patterns of gender inequality—texts that, in the terms presented here, deploy invisibility and stereotype strategies—are responsible for transmitting or reproducing these patterns. Thus, for example, Arikan *et al* (2005) suggest that representations of gender (also of age and social class) in English language teaching coursebooks have an effect on the ways in which teachers and students view the world. Keretsky (2009) suggests that textbooks can present a 'hidden curriculum' that is identity forming in terms of gender. Esen's (2007) analysis of new textbooks in Turkey argues that they perform a function of gender segregation that runs counter to an apparently 'gender-blind' reform of the curriculum in that country.

These transmission models, however, may be accused of unduly simplifying the situation insofar as they remove the textbook from the conditions of its use. After all, we have described Sime's photograph as consonant with dominant patterns of inequality, yet it is used, for the most part, in the context of challenging these patterns, presenting alternatives that are dissonant with them, thus shifting the text, now in context, to interrogative mode. Sunderland et al suggest,

> … rather than looking 'in the text' for bias, or even looking diachronically for improvements in textual representations of gender, a more relevant and fruitful focus in terms of both language learning and gender identity may be the mediation of gender representation in textbook texts by teachers, through their discourse on those texts.
>
> Sunderland *et al* (2001; p283)

Interrogation is one possibility, of course, though Naureen Durrani (2008) found that the construction of the 'ideal' Pakistani woman in the elementary student school textbooks that she analysed were consistent with stereotyping practices more generally in the school and that student perceptions were also consistent with this stereotype resulting, for example, in their condemnation of women who violated *purdah*. Durrani describes the curriculum as

> … a set of discursive practices that constitute gendered subjectivities which serve the interest of the dominant groups in Pakistan—the military, religious leaders, and men—and marginalise and silence the interests of women, non-Muslims and civil society. The findings suggest the success of the curriculum in interpellating the students as subjects through which they become agents of national, religious and gender ideologies that sustain the existing social relations in Pakistan.
>
> (Durrani, 2008; p. 608)

Of course, the curriculum is not the only set of discursive practices at play:

> Although students' voices were in line with the curriculum, this does not rule out the influence of other cultural resources such as family, social class, ethnicity, peers and the larger social milieu in the NWFP. For this group of students, it seems that ethnic identity, class and the influence of the Soviet-

[3] The textbooks were from the SMP numbered series and from the later *SMP 11-16*, both schemes were published by Cambridge University Press.

> Afghan war as well as the current war on terror in Afghanistan may have reinforced the curricular impact.
>
> (Ibid.)

The processes of transmission that are necessarily invisible when looking at closed texts may be revealed by research, such as Durrani's that also deals with people. Sian Beilock *et al* reveal what was perhaps a less deliberate mechanism in the gendering of 'math anxiety'. They measured the mathematical achievement and gender ability beliefs (whether it is thought that ability in mathematics and reading is differentiated on gender lines) of 117 elementary school students at the beginning and end of a school year; they also measured the levels of 'math anxiety' and mathematical knowledge of their female teachers. The researchers found that:

> By the school year's end, female teachers' math anxiety negatively relates to girls' math achievement, and this relation is mediated by girls' gender ability beliefs. We speculate that having a highly math-anxious female teacher pushes girls to confirmed the stereotype that they are not as good as boys at math, which, in turn, affects girls' math achievement. If so, it follows that girls who confirmed traditional gender ability beliefs at the end of the school year (i.e., draw boys as good at math and girls as good at reading) should have lower math achievement than girls who do not and than boys more generally. This is exactly what we found.
>
> (Beilock *et al*, 2010; p. 3)

Teacher 'math anxiety', it is proposed, is realised in girls, but not boys, in such a way as to display stereotype strategies in relation to gender ability and this, in turn, is realised in the form of relatively weak mathematical performances. Now, here, we might speculate that the 'math-anxious' teachers are exhibiting invisibility strategies to the extent that they do not actually make explicit (perhaps not even internally) that their anxiety is associated with their gender. Yet the proposition by the authors suggests that girls manage to translate the invisibility strategies into stereotype strategies, themselves rendering the representation of traditional gender ability patterns explicit (at least, when they are provoked to do so by researchers). Invoking the social learning theory of Perry and Bussey (1979), they argue that, 'children do not blindly imitate adults of the same gender. Instead they model behaviors they believe to be gender-typical and appropriate' (Ibid.; p. 3). Insofar as children will attribute to textbooks the same kind of authority in terms of gendered identities that they attribute to their teachers, then similar kinds of argument might be made in terms of the transmission of these identities.[4]

This transmission as described by Beilock *et al* would appear to have installed in the girls a contradiction between a feminine identity and an identity as a successful mathematician, resulting in the attenuation of the latter. Other research has found evidence of similar tensions. Work by Boaler (1997a, 1997b) and Skelton *et al* (2010), for example, found that girls in 'top sets' have to find a balance between 'doing girl' and academic success. Girls, it is claimed, lack confidence with the pedagogic strategies—'the survival of the quickest' (Boaler, 1997b)—adopted in these classes. To be a 'proper school girl' demands that girls present as cooperative, diligent, conscientious with a care and concern for

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[4] Testing such propositions experimentally would be likely to generate ethical problems to the extent that one group of children would be working with materials that would be regarded as potentially harmful. A quasi-experimental design would be methodologically problematic in respect of controlling for teacher, student, school etc variation, though this would not render such a study valueless.

relationships with teachers and friends and a (heterosexual) interest in boys' (Skelton *et al*, 2010; p. 187).

All of this might be taken to suggest that girls' mathematics performances in general are likely to be lower than those of boys. At the time of publication—or at least, the authoring—of *The Sociology of Mathematics Education* (Dowling, 1998) this was just about true at age 16 in the UK. However, girls in the UK were outperforming boys in primary mathematics—they had been for a considerable time—and were overtaking boys in performances at 16, outperforming boys in terms of the number of General Certificate of Secondary Education (GCSE) passes at grades A* thru C in every year from 1999 to 2008.[5] For some time, girls had also been outperforming boys in most other subjects at this age in the UK and in other countries provoking what Katherine Hodgetts reports as a 'globalised moral panic' (Hodgetts, 2008; p. 466). The responses to this panic included the setting up, in Australia, of the Australian Parliamentary Inquiry into Boys' Education. Hodgetts conducted an analysis of the accounts presented by witnesses to this inquiry in which she discovered evidence of a prevalent, stereotype discourse of gender and ability that constructed girls as passive, compliant, oriented to meaningless learning—focusing attention on unnecessary details of presentation and so forth—and as products of pedagogic manipulation by, for example, rote learning. Boys, on the other hand, were believed to be active learners, resistant to what they perceive as meaningless tasks and as products of integrity in learning, achieving understanding. Ironically, what achieves academic success for girls is constituted as undermining the value of this success, whereas boys' failure seems to be taken to be an indicator of their preference for the more challenging route, which choice illustrates their greater potential. This certainly resonates with earlier work by Valerie Walkerdine (1989, also Walden & Walkerdine, 1985) that, whilst boys' could be interpreted as having 'flair' in primary mathematics, even though they might make lots of mistakes, girls' successes were often interpreted as the result of hard work, which is to say, not proper learning and unlikely to result in sustained success in the future. Just to add another twist, in the 2009 GCSE examinations, boys performed better than girls for the first time in a decade. This reversal coincided with a change in the form of the examination (see JCQ, 2009) though the girls' advantage had been reducing since 2005.

In any event, mathematics education research must address mathematical performances—of both boys and girls—and must also address the pervasion of strategies within mathematics pedagogy that are consonant with patriarchy. These strategies are clearly instantiated in some (many?) learning resources, but also seem to be present in the practices of teachers. Can textbook design assist with this? We have mentioned Dowling's (1991a) reference to the tokenism strategies in the scheme *SMP 11-16*. These strategies do constitute a dissonance with patriarchal expectations, but do so tacitly. Dowling's article refers to instances of characters in settings who are out of stereotypical position. These included a task in three parts, in which the first two parts referred to raids on a castle by a Viking chief and his sons; the third part:

> Yet another chief and his daughters stole 6941 gold pieces. The chief took 2417 and his daughters shared the rest equally. If each daughter got 348 pieces, how many daughters were there?

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[5] DSCF figures available at http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000826/SFR02_2009_SFRTables.xls (last accessed 25th May 2010). Take up of mathematics by girls post 16 is less encouraging, however, although girls still achieved more top grades than boys in A level and further maths (until 2009). (Around 40:60 girls to boys at A level and around 30:70 girls to boys at A level Further Maths.)

(SMP, quoted by Dowling, 1991a; p. 3)

'An unusual way, perhaps, to count your daughters' (Ibid). At that time, Dowling drew on the activity theory of Aleksei Leont'ev (1978, 1979) to describe the way in which the text, overall, constituted the solution of the mathematical tasks and the elaboration of mathematical skills as the goal of the pedagogic action so that the more or less arbitrary construction of the tasks themselves provided the operational means. The connotative dissonance of some of the 'public domain' settings (Dowling, 1998, 2010) of these tasks with patriarchal expectations was, he argued, thereby suppressed. This, indeed, did seem to be the case with these texts in use. Another *SMP 11-16* task showed a map of a park with the positions of statues of an unlikely collection of men (Christopher Columbus, William Shakespeare, Isaac Newton, Karl Marx, Albert Einstein and Elvis Presley) and two women (Florence Nightingale and George Eliot). A drawing showed the statue of the Victorian English novelist—still known by her *nom de plume*, George Eliot, though her *in real life* name was Mary Ann (or Marian) Evans—dressed as one would expect and with the name, George Eliot, clearly visible on the pedestal. In visits by Dowling to classrooms in which this text was used, no one had ever remarked on any aspect of the task. He reported the following conversation with a girl in one of the classes:

> "Who's this?"
> "It says it's George Eliot."
> "Do you know who George Eliot is?"
> "Is he a scientist?"
> "So who's on top of the pedestal?"
> "Florence Nightingale."
> "She's moved over to George's pedestal, has she?'
> "Yes."
>
> (Dowling, 1991a; p. 4)

In present day England, George might be more readily interpreted as a diminutive of Georgina, of course, rendering this instance of tokenism completely pointless. Dowling's intervention had been intended to provide a context for what we are now calling an interrogation strategy, rendering the dissonance between text and patriarchal discourse explicit. However, the text and the more general context of the mathematics lesson privileged mathematical action over the operational public domain content and so the student, possibly quite rightly, saw no need to pursue the apparent inconsistency. The potential anti-patriarchal petard, without even being recognised as such, was nevertheless successfully defused.

We—researchers, textbook authors, teachers—seem to be ensnared in a discursive web that offers us a choice between teaching mathematics and interrogating pedagogy by de-privileging mathematics. Girls seem to be offered a choice between femininity and real mathematical success. Is there a way out? Before addressing this question, we shall return to a consideration of social class and related patterns of inequality.

Putting the class into texts

As well as considering the gendering of mathematics texts, Dowling (1991a, see also 1991b)) also describes a preliminary analysis of the *SMP 11-16* scheme, then widely in use, in social class terms. This preliminary analysis revealed a resonance between certain properties of the textbooks and what used to be referred to as the 'quality' and 'popular' newspapers. Essentially, the books directed at 'high ability' students were weighty, both physically and verbally, whilst those directed at 'low ability' students were lightweight—being stapled booklets rather than bound books—and included far more pictorial text and far less verbal text than the 'high ability' texts. The use of humour in the two series was different as well: 'high ability' humour demanded an understanding of the mathematics; 'low ability' humour was generally disconnected from the mathematics and often made fun at the expense of it. These and other differences corresponded with differences in the form and content of the 'quality' and 'popular' newspapers. Furthermore, it was clear from an analysis of the content of the newspapers—for example, comparing the positions advertised in the jobs sections—and from data relating to their readerships that the 'quality' press would tend to connote professional middle class, whilst the 'popular' papers would tend to connote working class. The textbook differentiation thus connoted a social class hierarchy via its consistency with the media. It was also noted that the 'low ability' books had a marked tendency to emphasise manual activities, which were very much backgrounded in the 'high ability' books, a manual/intellectual distinction that, again, connoted social class. When looked at separately—which would be the students' view as they would generally see (at least, see closely) only one series of books—the two series of books can be described as deploying invisibility strategies in respect of social class. When taken together, the strategy overall is stereotype. In neither view is there any dissonance with traditional class hierarchy. Differentiation in terms of resonances between textbook and newspaper format—still linked with socioeconomic class—remains in mathematics textbooks currently in use in the UK. The foundation level textbooks in the Heineman/Edexcel series, for example, employs larger font size and more illustrations than the higher tier books.

The classification and listing of differences and similarities in this work does bear some similarity with some of the research on the gendering of mathematics textbooks that is referred to above and is certainly worth doing. However, in and of itself, it lacks any theoretical development. This was undertaken subsequently and the result formed the initial components of Social Activity Method (SAM) (Dowling, 1998, 2009).[6] One move in this direction was to make a distinction between what appeared to be, from a mathematical point of view, arbitrary and what appeared to be non-arbitrary text. Thus some text concentrated on mathematical forms of expression and on mathematical objects, whereas other text recruited non-mathematical expressions and/or content, such as tasks involving domestic settings. Settings that are strictly mathematical are referred to as esoteric domain; settings that are apparently non-mathematical are public domain. An analytic distinction can be made between the form or expression or signifiers of a textual segment and its content or signifieds. Expression and content can then be considered separately in terms of the extent to which they are strongly or weakly institutionalised mathematically. There is always a need to take context into account. Thus, $2x + 5 = 7$ is clearly strongly mathematically institutionalised in terms of expression. In respect of content, however, it would be weakly institutionalised if we are told that x stands for an amount of money in a public domain setting. If there is no public domain setting, then the content as well as the expression would be strongly mathematically institutionalised. The product of the two variables, expression and content, generates the possibility space in Figure 2.

[6] In the 1998 book, the term 'social activity theory' was used; this was changed to SAM in the later book to avoid confusion with some Vygotskian work and also for reasons of internal consistency. The analysis that follows has been radically simplified in both theoretical and empirical terms in order to accommodate to the limitation on space. We feel that it nevertheless has some value in respect of understanding the relationship between mathematics education and social injustice.

Figure 2: Domains of Action

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

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

This analysis generates four domains of action. The esoteric and public domains are the pure forms in terms of the mathematical institutionalisation of expression and content. The 'multicultural' task about equal shares of a lottery win, the Viking and his daughters and the George Eliot tasks are all constructed in the public domain. The descriptive domain is the domain of mathematical modelling, where mathematical expression is used to describe a public domain setting. The expressive domain is the domain of pedagogic metaphor—an equation is a balance, for example, or a fraction is a piece of cake—where non-mathematical expression signifies a mathematical content.

Another move (Dowling, 1994, 1996) was the introduction of the category, discursive saturation. Texts that exhibit high discursive saturation (DS^+) will tend to render the principles of a practice—in this case, mathematics—explicit within linguistic discourse; texts that exhibit low discursive saturation (DS^-) do not. Clearly, mathematical discourse is only fully available within DS^+ esoteric domain text. This discourse, however, is the regulating discourse for text in the other domains. A key implication of this is that public domain text is not simply text in an activity other than mathematics, but is the product of a recontextualising action, a gaze cast from the esoteric domain that privileges mathematics over the regulating principles of the activity from which the recontextualised setting has been taken. Put simply, shopping, for example, in a public domain school mathematics text is very different from domestic shopping, it is mathematised shopping. The public domain, then, is not real mathematics, nor are its actions structured in the same way as those of the activities that appear to be being signified; the Viking/daughters text is, in this sense, not unrepresentative. The public domain constitutes a world of mythical practice.

The domains of action schema and the category, discursive saturation, arose—along with a number of other elements of SAM—out of the engagement with the *SMP 11-16* texts. Analysed in these terms, it was demonstrated that the 'high ability' books—and we can now associate these with relatively high socioeconomic status (s.e.s.)—involved movement between all four domains of action. The public domain often served as a portal into mathematics or as, shall we say, a playground for mathematising. Entry into the esoteric domain—often via the descriptive and (less frequently) the expressive domains—was almost always facilitated[7] and DS^+ text was prevalent. The 'low ability'/low s.e.s. status books, on the other hand, remained almost exclusively within the public domain. This was interpreted, by Dowling (1998) as providing a real mathematical career for the 'high ability'/high s.e.s. students, whilst 'low ability'/low s.e.s. students were confined to a domain that had no value

[7] An interesting exception being chapters on probability, where entry into the esoteric was delayed very considerably (Dowling, 1998).

either in mathematics or anywhere else other than in the classroom. There is a sense in which the mathematics curriculum, as represented in the *SMP 11-16* texts, can be understood as a mechanism for translating s.e.s. into 'ability'. This is consistent with a good deal of the sociology of education of the 1970s and 1980s, where social class was a key focus.[8] On the basis of the discussion above, it seems appropriate also to consider schooling as a device that translates gender into ability, though the mechanisms are different.

Further reflection on the esoteric domain of school mathematics suggests that the mathematical practices that constitute the esoteric domain are very substantially dissociated from any other practice (Dowling, 2010). School mathematics is very different, by and large, from university mathematics and from other school subjects, even apparently mathematical subjects, such as physics (Ibid.). It is not that there is no relationship between these different activities—clearly there is—but that this relationship is more appropriately thought of as one of recontextualisation rather than of progression or of direct use-value. The esoteric domain of school mathematics thus emerges as a region of essentially self-referential practice. To this extent, it may be appropriate to regard school mathematics as apprenticing both low s.e.s. and high s.e.s. students to mythical practices, the difference being that high, but not low s.e.s. students emerge with the symbolic value of school certification. The question that we now need to address is, can we do anything about this?

Critical mathematics education?

Here is Judith Butler on signification:

> As a process, signification harbours within itself what the epistemological discourse refers to as 'agency'. The rules that govern intelligible identity, i.e., that enable and restrict the intelligible assertion of an 'I', rules that are partially structured along matrices of gender hierarchy and compulsory heterosexuality, operate through repetition. Indeed, when the subject is said to be constituted, that means simply that the subject is a consequence of certain rule-governed discourses that govern the intelligible invocation of identity. The subject is not determined by the rules through which it is generated because signification is not a founding act, but rather a regulated process of repetition that both conceals itself and enforces its rules precisely through the production of substantializing effects. In a sense, all signification takes place within the orbit of the compulsion to repeat; 'agency' then, is to be located within the possibility of a variation of that repetition.
>
> (Butler, 1990; p. 145)

We can, perhaps, see the 'compulsion to repeat' in the invisibility and stereotyping strategies illustrated by the Sime photograph and by the *SMP 11-16* texts that signify social class—we're now using s.e.s.—in a way that is consonant with the dominant pattern. Do we see agency in the use of the photograph in newspaper and magazine articles that seek to change the patterns of privilege in schooling, or in the tokenism of the 'equal shares' text or the Viking and his daughters? Again, we see the 'compulsion to repeat' in Beilock's math anxious teachers and their female students and also in the witness reports analysed by Hodgetts. Do we see agency in Dowling's attempted provoking of interrogation in the 'George Eliot' classroom? Indeed, do we see agency in analysis that renders explicit significations consonant with patterns of dominance such as that reported and presented in this chapter? Perhaps we do, but Butler has taken us only part of the way, leaving open the

[8] See, for example, Bernstein (1971), Bourdieu & Passeron (1977), Rist (1970), Sharp & Green (1975), Willis (1977), Young (Ed) (1971).

matter of principles of realisation of repetition and agency; there is no sociology in her account of signification. We can try to activate the social as follows:

> … borrowing from cybernetics … the sociocultural [is] 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 …
>
> (Dowling, 2010; p. 1)

In this conception, repetition and agency are combined in autopoietic (self-making) action and 'rule-governed discourses' are socially grounded as alliances and oppositions; action relates to a field of social relations not just to discourses. Thus, invisibility and stereotype strategies constitute action that relates to the maintenance of, for example, patriarchal alliances; tokenism and interrogation, then relate to the maintenance of anti-patriarchal alliances that stand in opposition to patriarchy.

What makes an alliance visible is the regularity of practice that emerges from the totality of action in the field. Thus the field of mathematics education may be understood as an alliance of teachers, textbook authors, guardians of curricula and official assessments, mathematics education researchers, and so forth. This is not a tight alliance. Nevertheless, a practice emerges that articulates mathematics with what we might refer to as pedagogic theory and it is the latter that facilitates the gaze of the esoteric domain and the construction of the other domains of action (Dowling, 2010), generally privileging the mathematical discourse of the esoteric domain. [9] This privileging is sustained by the strong institutionalisation of curricula and the official assessment and certification schemes through which school mathematical performances are held to account and also by the visibility of learning resources primarily textbooks—to institutionalised interests beyond the classroom (for example, the family, media, and so forth).

Clearly, participants in the mathematics alliance are also participants in other alliances including those that are concerned to contest social injustice. We can see the impact of this juxtaposition in the deployment of strategies that are dissonant with dominant patterns of social inequality. We would expect these strategies to have the most impact where the dissonance becomes explicit, which is to say in interrogation, in critical mathematics. An example of such a move can be seen in a mathematics lesson conducted by Eric Gutstein (2002) that is discussed in Dowling (2010). Gutstein was concerned with the teaching of the statistical concept, expected value, and had discovered that the random number generator that is available on graphing calculators was a useful resource. He was also concerned to develop mathematics as a critical discourse in respect of social inequality. In his lesson, he recruited statistical information on the number of traffic stops made by police in Illinois by ethnic group. Gutstein and his class discovered that the number of stops of Latino drivers was very substantially more than the expected value predicted by the calculator and concluded that the Illinois police were racist. However, not only might one suppose that the ethnicity of the driver is often unknown to police officers in advance of the stop, but random traffic stops are actually illegal in the US, being a breech of Fourth Amendment rights; the police have to have a reasonable suspicion that an offence has been committed before proceeding to make the stop. Clearly, any association found between ethnicity and s.e.s. that made it more likely that Latinos, in comparison with white professionals, would be driving old and poorly maintained vehicles with visible defects may contribute to the explanation of the

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[9] Though there are exceptions, see the examples from TIMSS in Dowling, 2007.

disproportionate number of stops of Latinos. This is an indicator of social inequality, but it is not evidence of police racism. On the contrary, accusations of police racism on the basis of such data are explicit representations that are consonant with what appear to be predetermined assumptions about patterns of behaviour in society—just alternative stereotypes. Equally, of course, our interrogation of Gutstein's lesson does not in any sense constitute an assertion that Illinois traffic police are not racist.

The public domain setting of Gutstein's lesson has been achieved by a *fetch* strategy that casts a mathematical gaze onto an area of potential political significance and retrieves mathematically resonant features. This is not a problem, insofar as the students are also to be 'fetched' into mathematical discourse. A problem does arise, however, when the results of mathematical manipulation are then *pushed* back into the political arena, providing a simplistic and misleading response to a complex sociological problem. Any serious attempt to address this problem would have involved qualitative research, but that would have entailed losing mathematical control and that, we suggest, is not possible within the context of an institutionalised curriculum. Oddly, the Wilmette Police Department used the same statistical strategy as Gutstein (though, one imagines, without the use of the graphing calculator) to demonstrate that 'Wilmette police officers are engaging in bias free traffic enforcement' (Carpenter, 2004; p. 66). Ironically, their results raise exactly the same sociological questions as Gutstein's lesson and for similar reasons these questions are not going to be followed up. Despite his earnest intentions, Gutstein is recruiting politics for mathematical purposes; the Police Department is recruiting mathematics for political purposes.

So, what is our answer to the question posed at the end of the last section—introducing this section—and in this chapter more generally: can we do anything about social inequalities within the context of mathematics teaching? Our first answer is, yes, we can continue to strive to enable all students to acquire erudite, esoteric domain mathematics. The second answer is that, of course, we must eliminate representations that are consonant with prevalent patterns of social inequality. However, attempts to move from tokenism to interrogation, whilst politically praiseworthy in terms of motive are unlikely to generate appropriate understanding of social injustice, because the public domain settings that we construct will always be mathematically motivated distortions of the alliances that we want to destabilise, resulting only in alternative stereotypes. The way out of this is to privilege our political motivations over our mathematical ones. Of necessity, this involves switching to another activity. It seems to us that this is probably the best strategy: we can be both mathematics educators and political activists, just not at the same time.

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