

‘WHY ARE WE DOING THIS?’: A CASE STUDY OF MOTIVATIONAL PRACTICES IN MATHEMATICS CLASSES

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In this paper I argue that looking at the meanings that mathematics classroom practices have for learners and the subject positions that these make available are central to understanding who succeeds, who fails, who enjoys and who detests maths, and so who decides to continue studying it. I explore this using a case study of the, often overlooked, motivational strategies used in an AS maths class arguing that the stress on the exam, competitiveness and procedural work engaged in make it difficult for students to come to think of themselves as mathematicians and so unlikely that they will study the subject further.

Veronica Sawyer [1] has just marked the second homework of her new first year AS-level group [2]. The topic of the homework was completing the square although a lot of the errors occurred in the students' manipulation of fractions. As a result she decides to suspend the normal curriculum and spend an hour looking at prime factors, highest common factors, lowest common multiples and then the four operations on fractions. She describes this as a “very, very simple” topic “dealing with very, very basic things” and further as “babyish”. The students progress through the work largely in silence and with few problems. Their teacher interrupts them at regular intervals to offer advice, call out answers, deal with queries and remind them how to deal with the operation rehearsed in the next set of questions. One particular student, Vicky is one of the first to complete the fractions exercises and has had no problems with it. This surprises her teacher who had commented at the beginning of the lesson that, given the mistakes Vicky made in her work, this lesson will be particularly useful for her. Mrs Sawyer asks her, “so it wasn’t that that was the problem? What was it?” Vicky pleads ignorance and suggests that, “perhaps it was just a bad day”. Mrs. Sawyer simply adds that it cannot be that because she has made these same errors twice, and the discussion ends.

This occurred during my observation of classes at a London college and struck me as typical of how, often in maths lessons, the assumptions of teachers about how maths is learnt cannot explain learners’ behaviours. The teacher’s conversation with Vicky indicates that she has assumed that the latter’s inability to apply a skill (in this case, the manipulation of fractions) in one context (in this case, completing the square) indicates a general inability to apply that skill in all contexts, and one that could be remedied by decontextualised drill and practice of the given skill. In spite of a mounting body of evidence to the contrary, maths teachers continue to act as though they are ‘delivering’ transferable skills to students and, as in this case, disappear the parts of their lived experience that cannot be understood within such a model.

In this paper I highlight some of those disappeared features. I argue, drawing on insights from situated cognition, post-structuralism and psychoanalysis, that it is the

practices in which maths students and teachers engage, the meanings they give to them and the possibilities these make available for their own identity work [3] which provide a better model within which to understand who comes to succeed and who to fail in the subject and crucially why some people choose to continue with the subject and some reject it. I focus on the practices through which teachers, explicitly and implicitly, answer the frequently asked student question “why are we doing this?” since constructing a rationale for one’s actions is a central part of identity work.

SITUATING THE RESEARCH: WHERE, HOW AND WHY?

The case study data used here are taken from an on-going project on gender and AS-level maths that combines classroom observations with student interviews at three sites: Grafton School, Sunnysdale Further Education College and Westerburg Sixth Form College [4]. They focus on subject choice, since it is in participation, rather than in achievement, that significant gender differences remain in the United Kingdom. The starting point is the idea that subject choices are a public disclosure of identity, a way of telling people who we are and who we are not. As such, they are intimately connected to other aspects of our identity work: importantly gender, class and ‘race’. This orientation to the project, together with my overtly feminist stance, guided the methodological and theoretical choices that I have made. In particular my methods involve the detailed discursive exploration of qualitative data and my theories aim to challenge the authority of mathematical knowledge and to politicise maths classes.

I interviewed 12, 13 and 18 students at Grafton, Sunnysdale and Westerburg respectively during their AS course. Also, during Autumn 2001, I have observed two weeks of lessons in each of the classes attended by my participants. In this report I concentrate on some of the findings from my observations, looking in detail at Mrs. Sawyer’s AS class at Westerburg. Westerburg is a college with about 800 ethnically diverse 16-19 year-old students and a mostly academic curriculum; it is always oversubscribed and so has a highly competitive entry policy. It has a large maths department, with over 300 students being taught advanced maths courses by six full-time and one part-time members of staff. In order to qualify for entry to an AS maths course students must have at least a grade B pass from the higher level GCSE examination, although occasionally exceptions are made [5]. I have drawn on my observations in Westerburg here, rather than those in Grafton or Sunnysdale, because sixth form colleges are now the most common route through which young people gain AS and A-level maths qualifications. I chose Veronica’s group because, of the four Westerburg teachers I observed, she was the one who most commonly invoked the requirements of the examination as an explanation for her teaching practices and so provided the most unambiguous message to students regarding the purpose of her classes. However, there were also more personal reasons for my choice. While Veronica is clearly a good and experienced teacher who cares a great deal about the young people in her classes she told me, “most of the [students with GCSE grade]

B's fall by the wayside". This statement troubled me more than any others I heard teachers say and I think that I wanted to look at the ways in which such an outcome could seem natural and unproblematic. Retrospectively, I suspect that the way I see her teaching style as the most different from my own was an unconscious motivation for my choice, since it makes my analysis less threatening to the identity work I do in constructing myself as a 'good mathematics teacher'.

I was a participant in the classes I observed. However, my position was an ambiguous one and my participation differed from that of either the students or the teacher. I sat with the students, obeyed instructions from the teacher, took notes (although of course very different ones to the other students), and was occasionally used by students to subvert the teacher's intentions. I also adopted some teacher-like practices: assisting students with their work, hanging out in the maths staff office, and even though I encouraged students to call me Heather I often found they addressed me as 'Miss'. I took detailed field-notes that I wrote up within a day of the experience. I then worked through these notes identifying and classifying incidents according to themes that emerged from the data. I do not see the process of these themes' emergence as one of my discovery of the intrinsic truth embedded within my data, as perhaps grounded theory approaches would suggest, but as one of creative invention on my part. Although this was a process of invention that often surprised me, what I noticed and how I understood it were influenced by my theoretical framework, so I will outline this before giving an account of the observations.

SITUATING PRACTICE: MEANING AND BECOMING

The weakness of the traditional, functionalist model of the transfer of skills within maths, highlighted by the mismatch between Veronica Sawyer's expectation for the lesson and the actual outcome of it embodied in Vicky, was famously challenged by Lave's (1988) study. Lave compared the near perfect performance of people she names 'just plain folks' on best buy calculations with their much weaker scores on a maths test covering the same numerical skills. Lave developed a different way of looking at learning to help her understand her findings, a perspective she calls situated cognition in which maths and learning are conceived of as social practices, taking place within communities, and learning is never context free. This is a significant shift for it recognises that although "people clearly do transfer ideas, feelings etc. from one context to another under all kinds of conditions...what they transfer is not always what we in education would like them to transfer" (Evans, 1998, p. 285). This approach displaces the power of maths; it is no longer seen as an absolute body of knowledge, but as something people do. Within this framework the opposition of abstract and concrete knowledge is viewed in terms of the socio-cultural practices within which the differently classified objects are learnt. The explanatory burden for problems experienced in teaching is shifted from the cognitive and the pedagogical to "issues of access, and...the transparency of the cultural environment with respect to the meaning of what is being learned" (Lave

and Wenger, 1991, p. 104-5). If the 'ability' to perform a certain skill is tied to the context in which we are asked to perform it, this means that a variety of things impact on it, including the language and situation in which the task is framed, the physical environment, the actions of other learners and of the teacher, and the other experiences of the learner in which these are embedded. Evans (1998) work on adults' mathematical problem solving points to the complex interweaving of desire and discourse out of which individual performances are constituted. I concur that:

In a given setting subjects in general *are positioned by* the practices which are at play in the setting *and* that a particular subject will *call up* a specific practice (or mix of practices) which may differ from those called up by other subjects, and which will provide the context for that subject's thinking and affect in that setting. (p. 274, original emphasis)

So the meanings of the practices for those doing them are complex mixes of the structural, the environmental and the psychic, and hence are intimately tied to the way we talk about ourselves, that is to our identity work.

It is this research that situates my approach in the analysis that follows. I am seeking the meanings that students and teachers give to what they are doing in their classroom communities of practice. Thus, it is not what maths is or is not that matters but what it is constructed as being and as not being; the stories we tell about it; the discourses through which it is constituted (Walkerdine, 1998). And also the subject positions that these make available to learners, the way in which maths becomes part of their identity work. I start where Lave and Wenger do with what people do.

SOCIAL PRACTICE IN A MATHS CLASSROOM

The lesson described earlier in this paper was typical of the way students in this maths class generally work individually on repetitive exercises that practice set procedures, when they are not being taught didactically. Mrs. Sawyer's decision to improve the group's skills by going back to basics exemplifies the way she feels that maths has to be done in a particular order. In another lesson she comments that they are going to do all the operations on polynomials except for division. She explains that it would be a waste to tackle division before the group have learnt more techniques. This discourse of a hierarchy of knowledge in which she inscribes mathematics, renders pointless the doing of topics out of order. However, it exists in awkward relationship with the way in which different syllabuses and different textbooks put topics in very different orders. The fact that division of polynomials has shifted in the new AS course from the second to the first year, and the fact that at least one student has already covered this topic, provide further contradictions.

Within this hierarchy of knowledge some topics are located near the top of the scale, as 'hard' and others near the bottom, as 'easy'. As the lesson described at the start further demonstrates Mrs. Sawyer often described the latter as 'babyish'; this association with a younger state being carried through by their being labelled as

junior school or GCSE work. Such references draw on and fuel a series of parallel binaries in which 'baby' work is 'easy' and opposed to 'grown up' methods that are 'hard'. These are gendered, with the masculine 'hard' also opposing the feminine 'soft', and classed, because certain aspects of middle-class 'cultural capital' are commonly taken as signifiers of mathematical maturity and 'ability'.

In looking for meanings in maths classes many researchers have discussed the way that sense-making is absent from overly procedural, competitive maths lessons. Boaler commented on the maths classrooms that she had encountered:

It seemed to me that in most of them, it was as if there were a kind of check-in desk just outside the classroom door labelled 'common sense', and as the pupils filed into the classroom, they left their common sense at the check-in desk saying 'Well we won't be needing *this* in here'. (1994, p. 554, original emphasis)

In a later study Boaler (1997) reported that many students, but particularly girls, found their 'quest for understanding' frustrated by the fast paced, repetition of techniques that dominates top set maths pedagogy. Veronica Sawyer's approach to the 'quest for understanding' is interesting. On a couple of occasions during exposition of demanding topic areas she substitutes belief for understanding, so for example her discursive framing of a topic shifts her from comments like "I know this is hard for an afternoon lesson" to "you've got to believe me, it's not magic, you've got to believe me, I'm not fooling you". Alternatively she often suggests that the quest must be deferred, "you've got to be patient with yourself when you're learning"; understanding will result from time, effort, and hard work. This construction of understanding is used as a rationale for stemming the flow of student questions. However, I would argue that the most important difference between the 'quest for understanding' of the girls in Boaler's study and the one that Mrs. Sawyer wants her class to pursue is its motivation. She makes clear that it is the examination that defines not only what understanding is needed, but also whether you have understood or not; an external authority replaces internally authorised sense-making.

The spectre of the examiner as a disciplinary presence in the classroom

As you would expect in all of the maths classes I observed there was some mention of the exam. However, the frequency and nature of such mentions was very varied. In Veronica Sawyer's class the exam itself was discussed often and the teacher used many opportunities to describe exam technique. However, it was largely through the constructed figure of 'the examiner' that the exam made its presence felt. This examiner is sometimes a hard taskmaster (male labels/pronouns are used here advisedly) rigorously insisting on one form of answer over another and at other times a doddering old man who may find messy work "confusing". The examiner guides the choice of methods as when Mrs. Sawyer instructs her students to score neatly through each term when expanding brackets so that the person marking your script can still see it and to write "comparing" when comparing coefficients in order "to

show off to the examiner that you're a logical person". That the examiner is also the ultimate arbiter of right and wrong in the eyes of the students is clear from Imran and Saeed's comments to me during a lesson on inequalities. When I point out to Imran that he has used $=$ instead of $<$, he says twice "you know what I mean" and then shifts to "the examiner will know what I mean". While Saeed, who gets the answer ' $-x < -4$ ', wants to know how to get the answer at the back of the book. After I explain he wants to know (referring to his original solution) "will they mark that as right in the exam?" However, exams carry with them constant evaluation, not only against the requirements of the examiner, but also against each other. As Denscombe (2000, p. 370) found students recognised that exams offered "the prospects of success or failure which could be used as a 'measure of the person' on which to make comparisons with others". Next I look at the way this process of comparisons was played out and encouraged in the classroom.

How do I measure up? Competition within the classroom

During the ten hours of lessons that I watched there were two short tests. These tests are clearly linked to improving student performance in the exam. However, competition seems to be a motivation over and above this. In both cases students are required to declare their marks in front of the rest of the class. Veronica also sustains a competition between this group and her parallel first year class, whom she describes as "my other set, my decision maths set, that you're in competition with". When several members of the group provide her with the correct answer to the product of $4x^3$ and $3x^2$ she praises them with the words "you've already beaten my other group" (who had offered the incorrect solution of $12x^6$). They are similarly praised for naming the most basic numbers as "positive integers" rather than "counting numbers" as her other group suggested. And in fact while the students are working individually and in silence on some test questions she describes the errors made by her other group as her reason for doing this test adding to me (but clearly audible to the whole group), "I just wanted to see if this lot could beat them".

Veronica emphasises not only the differences between her groups but also the differences within them. For example, when I am recruiting students for interviews she several times encourages me to take some of them out of lessons explaining that there are a couple of people that I could take out now and it wouldn't matter that they had missed a lesson. She draws on two discourses to explain these differences: 'lack of preparation', which is used to explain how some are doing less well, and 'natural ability', which is used to explain how some are doing better. Although not explicitly invoked to explain failure, the use of a discourse of 'natural ability' to explain success, necessarily carries with it the implication that lack of 'natural ability' contributes to lack of success. Yasser is an example of how these positions are lived:

Yasser is referred to by his teacher as "naturally able" and is clearly marked out as different. He is sometimes given different work to do and on one occasion is asked to teach the class his method for tackling quadratic inequalities. At first he tries to explain

his solution to her verbally, but this proves difficult so he suggests “shall I write it?”, to which Mrs. Sawyer responds “please do”. When Yasser writes up his solution there are many looks from students that combine amusement and bemusement. Imran declares “that is so complicated, I’ve never seen that in my life” and next to him AJ has his hand up, while Saeed says to his teacher “he’s clever isn’t he?”, then adding “he should do further maths”. She agrees with him, “he should but he’s busy doing other things”. Saeed asks her “why don’t you encourage him to do further maths?”, to which she responds “I’ve tried, it’s his choice”. Yasser has now completed writing up not just his original solution but also the graph that Mrs. Sawyer asked him for when his first approach appeared obscure. AJ asks “what is that?”, and then repeats the question. Sanjay has a furrowed brow and his hand up. Then Mrs. Sawyer steps in and goes up to the board and explains the graphical method while leaving up Yasser’s work because “it is worthy of honour”. She further suggests that you could make sense of his diagram by putting numbers in “but you’ve done it theoretically like a good pure mathematician”.

Yasser is constructed here as a mathematician. However, the manner of this construction as an esoteric being, a curiosity, “the spectre of mathematical ‘genius’” (Bartholomew, 2000, p. 4), as *Other*, makes it more difficult for the rest of the group to share this position. In concluding, I examine what positions are available to them and the consequences for their identity work.

BECOMING A MATHEMATICIAN?

Learning “implies becoming a different person” (Lave and Wenger, 1991, p. 53) and the 16 students in this class are all engaged in making themselves, in a creative response to the constraints imposed by the situations in which they find themselves. I have argued in this paper that Mrs. Sawyer’s classroom, in common with many maths classrooms, is one where the motivations, the reasons given for doing maths, promoted are not the intrinsic ones of pursuing a ‘quest for understanding’ or gaining enjoyment from it; that is not ones that make available a position as a mathematician. Thus in their identity work, in making sense of what they do and who they are, they look for other motivations and positionings. They become rule followers, good or bad students, ‘naturally able’, bottom or top of the class, among other things. But above all, they become exam passers, where this goal is officially about progression through the educational system and building a career. However, for students, exams are not just to get jobs; they have a powerful impact on young people’s self-image. That this is not recognised within classroom discourses creates conflicts for learners, particularly those who previously saw themselves as enjoying maths, who often come to see the maths that is on offer as incompatible with their identity work:

Where there is no cultural identity encompassing the activity in which newcomers participate and no field of mature practice for what is being learned, exchange value replaces the use value of increasing participation. The commoditization of learning engenders a fundamental contradiction between the use and the exchange values of the

outcomes of learning, which manifests itself in conflicts between learning to know and learning to display knowledge for evaluation. (Lave and Wenger, 1991, p. 112)

NOTES

1. All names of people and schools and colleges have been anonymised.
2. This is a qualification taken after compulsory schooling, usually between the ages of 16 and 18.
3. Identities are unstable, contradictory, and multiple. Identities are the way we have of talking about ourselves, and are constantly being produced in our actions and our interactions with others; identities are always in process and never attained. However, the word 'identity' suggests coherence and completeness so I have decided instead to use the phrase 'identity work'. Stuart Hall in his work (see Hall, 1996) imbues the phrase 'identification' with similar meanings.
4. Sixth form refers to the educational phase involving 16-19 year-olds; Further Education denotes all post-16 education.
5. The GCSE is usually taken at age 16 and pass grades go from A* down to G, it can be taken at the three levels of foundation, intermediate and higher.

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