Taking a visibility perspective on gendering in secondary school mathematics

Cathy Smith, The Open University, cathy.smith@open.ac.uk

The theoretical perspective of visibility has been used in organisation studies to understand how participation can be constructed differently for minority and majority groups. This paper combines liberal and poststructural approaches to understanding who is made visible, and how, in mathematics practices where choice aligns with gender. I re-analyse existing data from case studies of English schools with high mathematics participation for girls aged 16-18. Within these accounts of girls' experiences, prevailing discourses are those that render boys' struggles and successes highly visible. Quiet effort serves as an invisible background that is ascribed to girls and to maturity. In contrast, the hypervisible girl achiever is understood through a single aspect of identity – mathematical success without struggle or support.

Introduction

With recent constraints on classroom access and data collection, it has been instructive to focus on existing data from a different theoretical perspective, allowing for the possibility of forming new conjectures with a different explanatory empirical reach (Inglis & Foster, 2018). This paper focuses on a re-analysis of some data from a series of case studies (Smith & Golding, 2018) that examined accounts of practice in five English schools or colleges whose participation rates showed that they were successful in recruiting girls into pre-university mathematics. This is in the context of an education system where students aged 16 choose a specialist education pathway and, if they have already achieved a threshold performance, may study no mathematics. In 2019, 54% of girls studied no named mathematics course aged 16-18. Among the two-thirds of students choosing a pre-university 'A level' course, 20% of girls chose mathematics as one of their subjects compared to 37% of boys.

The original study and thematic analysis were designed to focus on the characteristics of the selected schools in terms of identifying any (1) intentional strategies addressing girls' participation or (2) aspects of mathematics pedagogy, careers or teacher guidance that support girls' participation, and how these were conceived, operationalised and evaluated by teachers and girls? The re-analysis focuses on a third research question:

What messages are current in the school culture about who does mathematics?

There is an argument that girls' participation in mathematics is limited by the absence of role models and messages – that if you cannot see it you cannot be it – but much research into subject choice suggests that simply seeing and hearing a message is not enough.

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Students themselves are critical receivers of media tropes such as 'Girls can do maths too' (Mendick et al., 2007); while exhortations can remain as imagined futures if there is no family "science capital" that makes pathways compatible with lived aspirations (Archer et al., 2014). My previous research (Smith, 2010, 2020) has focused on how individuals are positioned within educational discourses as construing themselves, in ways that are socially and institutionally intelligible, as adolescents who express themselves through their choice (or not) of mathematics. These complexities of messaging and identity performance have also been recognised in theoretical work in gender and organisation studies, notably within Lewis and Simpson' (2010) work on surface and deep levels of analysis within studies of workplace voice and visibility. This paper discusses bringing these theoretical perspectives from organisation studies to the original data.

Visibility; invisibility and hypervisibility

A theoretical perspective that studies voice and visibility is not new. It starts from an assumption that differences should be valued and asks 'Where are the voices or the people who embody those differences and why they are missing?' It points out the damage to institutions of missing those voices and also to individuals. People's workplace credibility and self-definition rely on being perceived in a way that they desire, so organisational studies should examine for whom and why this is not happening (Buchanan & Settles, 2019). Lewis and Simpson (2010) characterise this strand of visibility research as aiming for reformation rather than transformation of existing structures. It is based in a liberal feminist worldview (that is, one conceptualising equality as freedom for all) and hence it seeks to fill gaps caused by the absence of important voices and to reconfigure the reception of those voices to create more neutral grounds for participation. So far, so good and I will return to insights from such studies. However, Lewis and Simpson oppose this "surface-level" strand to a "deeper" theorisation that examines the silences in organisations and what they achieve. This strand is based instead on a poststructural worldview that identity – including gender identity - is performed and regulated in discourse (Butler, 2004; Rose, 1998). In such research, the invisibilities of women in undergraduate mathematics (Rodd & Bartholomew, 2006) or of Black girls in STEM-promotional materials (Brink & Stobbe, 2009) are understood as ongoing processes of rendering invisible or of diverting the gaze, rather than as omissions. The silences we should examine are not only those that are imposed on, or chosen by, minority group members but also the silences that are taken-for-granted. These constitute the norm and they position some of us – often White, men, straight and older – as dominant, both through our invisibility within a background culture and also as spectators of those who differ from that constructed norm.

The work done by Simpson and Lewis in recognising these two theoretical strands is important, but their characterisation as 'surface' or 'deep' misses the pragmatic nature of much of education research: although we owe it to the future to transform our education systems, we also have a reforming goal to make a difference to the students who are studying

now. Education research could use poststructural theoretical insights that question the processes of rendering visible or invisible to suggest changes within current institutional practices, or at least to understand better the ways that these structure participation for a variety of participants with multiple identities.

One important concept that emerges from the more liberal strand of visibility research is that of hypervisibility, describing a process where a person's multiple allegiances and positions are projected as a single identity. In this form, the condition for becoming visible as a worker is to become an embodiment of difference, requiring their behaviour to represent the category. This can present as tokenism for those in minority groups and exposes people to continued surveillance for belonging (Buchanan & Settles, 2019). Hypervisibility is also identified as a strategy for defining the norm. Organisation studies within university mathematics departments identify the hypervisible normative scientist as highly-focused and performative (Brink & Stobbe, 2009; Jaremus et al., 2020).

A useful insight from poststructuralism is that visibility is re-constructed at many levels, ranging from cultural and institutional practices to peer interactions and self-talk: "social structures are the medium and the outcome of the actions they recursively organise" (Brink & Stobbe, 2009, p. 453). Discourses circulate power, and 'coming to know' who you are and what is expected of you is not only repressive but also productive. This productive perspective gives meaning to repeated findings that people may act to render *themselve*s invisible or hypervisible as a way of erecting barriers, reducing discomfort, inviting or defending against scrutiny (Rabelo & Mahalingam, 2019; Smith, 2010). Although visibility processes are available to all, the conditions of using them are asymmetric, in particular in relation to which identities or practices can be enacted 'in the background', without attention. There are risks for minority groups in both exposure and disappearance (Lewis & Simpson, 2010).

Although it originated in employment studies, this discursive theoretical framing of visibility resonates with the complex and contested performances of identity in 14-18 classrooms. These are helpfully understood as ways that power circulates through framing young people's knowledge of themselves and others, inscribing who can act in what way and in what conditions of visibility. While overall discourses tend towards reproducing dominant practices, moments of alterity exist and discourses do change, both locally and globally.

The 'surface' and 'deep' approaches also bring different methodological priorities. Visibility is often approached through collecting personal accounts. Primacy is given to experience: experiences such as your voice, your body or your work being unseen or neglected. Focusing on commonalities between accounts may reveal or give substance to a theme that has previously been ignored - such as the experiences or knowledge of a minority group. On the other hand, a poststructural view of discourse argues that this is not enough: experiences are given meaning by discourse and dominant discourses function despite and even maybe because of the ways that some constructions of knowledge are ignored or sidelined. Focusing

on what is the same about minority group accounts will re-enact this spotlight on taken-for-granted knowledge. Instead, purposefully studying *within* group variation may point to factors that trouble dominant narratives (Leyra, 2017; Gholson, 2016). In this context, exploring the multiple different ways in which one can be a girl choosing mathematics can show the multiple points of tension or alignment that lead away from choosing mathematics.

The study

The data from the original study was collected in four 11–18 schools and one 16–18 college. The focus was on the proportion of girls studying any A Levels who chose mathematics as one of their 3–4 subjects, as evidenced by national school data published between 2012 and 2016. It is known that girls' mathematics participation is higher in schools that are independent, academically selective or single-sex (Vidal Rodeiro, 2007) so after ranking the data, those sites were excluded, as well as small schools. We then purposefully sought a mixture of school types and sociogeographic settings. Six sites were approached and five agreed, selected from the eighth to tenth deciles for participation over the previous 2 years.

The original study was carried out by two researchers who collected the following data in each site:

- Participation data by gender and examination grades for 3 years, permitting analysis of the attainment profile of the girls who chose mathematics.
- Focus group interview of 3–5 mathematics teachers to explore their strategies for retaining girls in mathematics
- Focus groups of girls (7 in total; with 18 girls before choosing A level, and 29 who had chosen mathematics)
- 1–2 observed mathematics lessons: field notes focused on local factors proposed by teachers as promoting participation.
- Interview with lead teacher in subsequent year

The current reanalysis of this data by one of the researchers focuses on 23 texts consisting of field notes (4), focus groups (13) and interviews (6). Focus groups had been chosen as a data collection method to allow negotiation and collective agreement on accounts of strategies and experiences. The focus group schedule included prompts such as 'Does anyone think differently?' 'How do others react to that?' with the aim of soliciting diverse ways of accounting for individual choices (Mendick et al., 2007).

One purposeful decision was to focus the enquiry on girls' choices and experiences as of interest per se and not in comparison to boys'. When selecting the sample, for instance, the chosen metric highlighted participation among girls, not the relative composition of teaching groups. There were no focus groups for boys and the questions asked only about effects on girls. Two exceptions were asking the teachers to describe any school initiatives for boys that challenged traditional patterns of subject choice (after asking the same for girls) and asking the students explicitly if there were "any times in this school when people have implied that mathematics […] is more of a boys' subject than a girls' subject?" At the time of

data collection (2015) neither the researchers nor the participants challenged that binary framing of gender, which I would now rephrase to remove the direct comparison. As the subsequent analysis indicates, binaries are powerful discursive organisers of meaning in classrooms.

The data was analysed by coding sections of transcribed text in repeated passes. The thematic coding from the previous study (based on strategies, pedagogies and effects) was removed, although as one of the original researchers I am necessarily informed by meanings elucidated through that initial process. The analysis is both literal and interpretive (Mason, 2017) in that I use lexicogrammatic elements of the text in order to construct a version of what I take the data to signify. Throughout, the aim is to consider what positions and knowledges are made intelligible in the discourse in this setting.

The analytic framework was conceived around three dimensions, each of which was filled-in with detailed subcodes. The first of these is visibility, based on the analytic question 'Who are the subjects, and how are they positioned?' Coding was based on a combination of thematic prominence in the text and words such as 'notice' or 'stand out' that describe public attention. Subcodes included visible teacher enjoyment, boys' success and struggle, choice-making, hypervisible achievers. Initially there was no code for invisibility: in part because what is not mentioned cannot readily be coded and also because the nature of the interview questions made girls' participation a focus. The second dimension was the boy-girl gender binary. Text which explicitly included this binary was subcoded as to how this was ascribed relevance by the speaker: either 'an effect', 'no effect', 'a balanced effect' or 'traditional v fact' (for extracts where a stereotypical effect was simultaneously voiced and challenged). The third dimension was differences constructed in language. A systematic search was used to identify comparative words (e.g., 'but', 'more than') as well as juxtapositions of phrases that imply comparison through near repetition (e.g., "even if you don't like it [maths], you need it"). These instances were then categorised as subcodes such as 'like/ need', 'alone/supported', 'White British/Asian'. The whole data set was then recoded for any instance related to any part of these emergent themes, whether including a comparison word or not. That allowed categorisation into differences that appeared predominantly as binaries and those that require multiple possibilities. There were two of the latter: school subjects and home-culture. Although mathematics was the subject of interest in the interview, a range of subjects were drawn on for comparison. Home culture is considered by both girls and teachers to be relevant for participation; the speaker's own ethnicity and White British ethnicity were used as reference points for comparison but not exclusive ones.

Findings

Three aspects are reported in this paper: who and what are rendered visible, invisible or hypervisible in accounts of mathematics experience. These have been chosen for interest rather than as representative of the whole data set. They are findings that were highlighted particularly by the methodological approach.

Visibility

One notable subcode that emerged from the analysis was the visibility of boys' success and struggle in mathematics. This was coded in 13 of the 23 texts and across sites. As said above, boys' participation was deliberately made less visible in the questions and so its presence in the text shows how readily the structure of school discourse allows discussion to turn to comparison. One aspect of this was that boys were described as actively – and publicly - engaged in deploying for their own learning the classroom resources such as time, attention and ladders created by attainment setting. The extracts below illustrate this aspect of visibility, with T/S indicating teacher or student speakers and sites indicated as A–E.

TB: For us, the issue is how do we motivate boys, because the girls achieve more, so the squeaky wheel gets the grease – we're forever trying to think of ways to support boys more, to make it more equitable.

SC: I think it's more evident in maths. You like notice them more. I think the girls are more comfortable in their own sets. Like I think the boys want to go higher – like get higher in the set.

SA: It's only like a couple more. So it's not…obvious that there's more. But its obvious than they're more like…they talk more in the lesson.

This last comment concluded a focus group discussion about whether there were actually more boys in the top set (of 15 girls and 16 boys) or there simply appeared to be more. Together these comments suggest that mathematics lessons in these sites would be recognisable to many teachers of adolescents as largely led by vocalised contributions from boys ('squeaky wheels') with quieter, but still effective, participation by girls. Note that in school B the teacher describes them as achieving more. This prevalence of public talk by young men is identified through undergraduate mathematics (Ernest et al., 2019) as a factor in hiding girls' competence.

This visibility works to reinscribe men and boys as default mathematicians. Even in situations such as these schools where this norm was understood and challenged as an outdated stereotype, it touches on lived experience for boys and girls:

TD: My boys are really embarrassed about being in set 7: they just don't want to write it on their books, they try to distance themselves from it.

SC: You could argue that those…that's because there's a lot of pressure on boys to be all macho, so they… [others: Yeah, Yeah] …they express how well they've done. [Yeah] So the stereotype is even towards the boys, and that could be affecting which girls do it. Because they don't want to be… [the only girl] … boastful like the boys.

The second extract above introduces another aspect of the visibility of boys. The speaker's gap is filled in by another student with "the only girl". Completing sentences suggests a shared understanding and here that is the construction that boys' participation in mathematics is as part of the group while girls would participate alone.

Invisibility

Although there was no initial coding for invisibility, it is interesting to examine a few instances in which omissions were significant or contrasts were overturned. The first of these concludes a teacher discussion of maturity, and suggests that, by the age of 16, girls' achievement and conscientiousness are what is required in mathematics:

> TB: (Girls are) more used to working, generally, unless you've got really conscientious boys in the class, so the girls set the standards and expectations.

Here girls are taken to represent the invisible norm while similarly diligent boys would stand out as visible "really conscientious" participants.

There was just one response in which boys became invisible. In the school context, it is widely recognised that girls are more likely to study Psychology and not Physics. Implicitly, then, the references to 'they' and 'students' in the following refer to girls, rendering their circumstances universal:

> TA: I said, oh, we're starting mechanics next week. And some of them just go, ohh – because they automatically just have that perception of it's Physics. And I'm like, no; actually you will enjoy it. And they do when they get into it. And most students actually really enjoy mechanics. But I think with statistics a lot of our students do things that link ... Psychology.

The final example (Figure 1) challenges the idea that A level classrooms are always more feminised or inclusive spaces. It is an extract from field notes on a lesson on statistics in which a man teacher sought to remind students of the word 'consistent' in relation to narrowly spread data, asking twice 'What is the C-word?'. 'The C-word' is a common euphemism for a swearword referring to female genitalia.

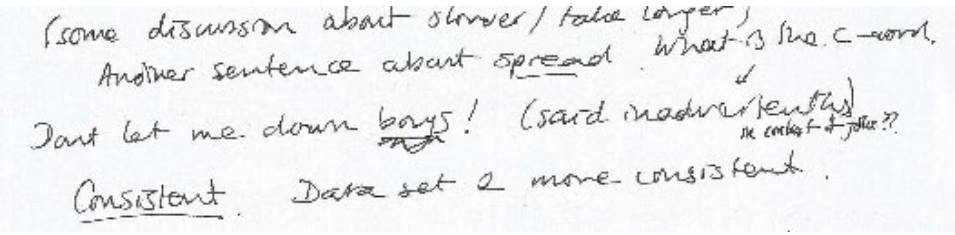

Figure 1. Extract from field notes

The point here is not that a teacher made a poor or unlucky choice of words, but that the way that he could then restore the pedagogic sense of the interaction was to call on "boys" to engage with him both as a teacher and personally ("don't let me down"). The 7 girls in the room looked at their desks until the teacher, with apparent relief, eventually received the answer he needed. The girls were rendered invisible by the intrusion of a wider sexualised discourse that excluded them – temporarily but very effectively – from hearing or replying to the teacher's intended pedagogy.

Hypervisibility

One of the positions that was available in mathematics classroom discourse was that of the hypervisible girl achiever. In two sites, both teachers and students referred to particular girl students who were good at mathematics, suggesting that others would recognise the person. This was coded as hypervisibility when that position focused on a single aspect of identity, and in both cases this aspect was achievement with effort but not struggle:

SC: She's ridiculously clever and she's just getting As in all of the tests. And she doesn't even need to worry about anything because she's so good at it. And she doesn't find that workload too much, whereas I think I would do.

SD: In maths there's sometimes a brick wall you have to climb over – unless you're Michelle of course! (laughs)

Michelle: I don't always find it easy – and anyway [teacher] says I'll find it harder when I get to university, but that's part of the fun of it.

As seen in the gender research, the hypervisible member of a minority group represents the possibility of participation but allows for a very narrow drawing of lines as to what counts as a girl mathematician. Both students who introduce the hypervisible girl achiever suggest that this identify is uncomplicated ("just", "all", "doesn't even need to worry", "unless you are… of course!") and distance themselves from that. Those in the position may seek to diffuse this. In her quote above, Michelle (a pseudonym) uses three qualifiers (not always, anyway, part of) and calls on their teacher as a liked authority and to future unknowns to complicate the way she has been presented. Those who are not hypervisible are also positioned in the discourse, but as spectators aware of how participation can be threatened and the work that is needed to maintain it alongside friendships and other relations. Thus in one of these schools a woman teacher suggests that "Girls I think often feel the need to be really, really good at [mathematics]" and the student focus group agrees that "Unfortunately most girls I'd say would probably just… they want to escape it rather than fight it…the stereotypes."

Discussion

The intention of this paper has been to highlight some findings from a process of analysing student and teacher accounts through the perspective of visibility. Perhaps the most significant finding is the confirmation that, even in sites that demonstrably promote girls' participation, and where the data collection focuses on this effort, the prevailing discourses are those that render boys' struggles and successes in mathematics classrooms highly visible. Students and teachers give prominence to meanings that honour individual choice and reject explicit gender stereotypes. Nevertheless, their discourse shows that institutional practices tend to defend the status quo. Boys' social visibility in the mathematics classroom surfaces in the data as their use of airtime, the valuing of their efforts to compete and their own problematising of their presence in lower sets. This naturalises a sense of belonging in mathematics. As other research has recognised, "the process of doing mathematics is

constructed as masculine" (Mendick et al., 2007, p. 22). What these findings add is that this construction remains dominant in settings which do in fact have high girls' participation.

It is worth returning to Lewis and Simpson's (2010) notions of surface and deep strands of theoretical thinking. The surface approach asks 'Where are girls voices and why are they missing?' The findings from mixed settings suggest that girls' voices are present but they are largely inscribing mathematics as a context for performances of masculinity in which girls are observers and/or out-of-the-spotlight actors. The deep approach asks 'What is achieved by this silence or invisibility?' The invisibility traced in these findings is girls' invisibility in the competitive and performative aspects of classroom practice that form social relationships. One effect is that of constructing their successful participation as private diligence. This is an example of how invisibility can circulate power productively; they are seen by teachers as setting standards of good effort and compliant behaviour. A second effect is that they can be excluded from public mathematical talk, particularly in situations in which gender becomes highlighted, perhaps informally. These are not distinct effects. Ernest et al. (2019)'s study of undergraduate classrooms showed that women's "hidden competence", evidenced by their participation in private group talk and informal explanatory 'sidetalk' during plenaries, was not matched by an equal contribution to public talk and was not reflected in how their achievements were recognised by peers or tutors. In this study, the effects combine to suggest that girls are isolated when studying mathematics, "the only girl". This position of isolation does not match the high participation rates in these schools, and further analysis is required to investigate how group participation is made intelligible by the binaries presented in the discourse.

One aspect of this may be the protective shadows cast by the positioning of hypervisible girl achievers as students whose identities are distilled to a single requirement of achievement in mathematics. This means that other students can position themselves as having multiple identities – being both girls and mathematicians – in a way that is complicated but unremarkable. Hypervisibility is not necessarily comfortable. Being accepted as a girl mathematician entails meeting high expectations in a setting where you are not visible as one of the girls. Brinke and Stobbe (2009, p. 465) call this the paradox of invisibility: "that visibility and invisibility as gendered practices and practising gender are part of the same organizational reality." They identify this paradox in the workplace and in academia, and these small-scale findings suggest it is present in schools.

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