The Construction of Identity in Secondary Mathematics Education

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Abstract

Drawing on data from 120 interviews with secondary schools students of mathematics aged from 14 to 18, in England and the United States, this paper argues that young persons' developing identities are an important, and neglected factor in success at secondary school mathematics. Students in both countries believe mathematics to be rigid and inflexible, and in particular, a subject that leaves no room for negotiation of meaning. However, while the lack of opportunity for understanding mathematics was important, a much more salient factor in determining students' attitudes towards mathematics was that they did not see success at mathematics as in any way relevant to their developing identities, except insofar as success at mathematics allowed access to future education and careers.

Introduction

One of the more persistent and widespread problems in mathematics education is that many students who are successful in mathematics give up the subject as soon as they are able to do so, even though they are aware of the limitations this places on future careers. Gender studies have sought to understand this phenomenon through a number of psychological viewpoints including attribution theory, locus of control and role modelling. Such studies have been useful in shifting the emphasis away from models of ability, but have not addressed the phenomenon as a social one. This paper represents an attempt to understand why some students will continue with their studies in senior mathematics, while others do not. We take the notion of "identity" as critical to our analysis. We contend that students who develop a sense of identity which resonates with the discourse of mathematics are more likely to continue with their studies than their peers who do not develop such a sense of identity. Critical to this proposal is the understanding of the processes through which students develop such a sense of who they are in relation to mathematics.

Psychological Studies on Identity

Most studies of identity formation have been grounded in psychological discourses —see Erikson's (1968) theory of identity development for example. Such theories posit that in the early stages there is a lack of awareness of an individual's identity in relation to a social or cultural group. As children enter the adolescent years they become more aware of who they are within the boundaries of a group and as such begin to explore the group mores. As they become more aware of their group (race, class, ethnicity, work, gender, etc) identity in relation to other groups, they become more committed and secure within their chosen group. Such theories are based on the age/stage ideology where it is posited that students will identify more with their group as they age and mature. In contrast, other theories relate to a more social psychological approach. Tajfel & Turner (1986) propose a greater attribution to the social aspects of identity formation. Within this approach, there is a greater emphasis on the person's sense of belonging to a group and the resultant feelings of security and other associated attitudes that represent belonging to a group. In part, belonging to a group is a seen to be a key component of a sense of self and self-concept whereby members develop a keen sense of the value of the group and group membership and as a consequence derive considerable self-esteem from belong to a particular group. In identifying the effects of identity in young adolescents Roberts, Phinney, Masse, & Chen (1999) have suggested that members who have a positive view of their group tend to have high self-esteem with the converse also being true. Other studies have indicated that there is a correlation between identity with a group and self esteem.

In attempting to define and measure "identity", such discourses have identified three components – a sense of belonging to a group; a sense of achievement within the norms of the group; and particular behaviours associated with belonging to a particular group – which are seen to represent key aspects of identity. These components provide indicators of key aspects to consider when theorising identity from a psychological standpoint. However, in order to understand how these attributes become manifested, it is important to consider the social contexts within which such attributes are developed.

Mathematics as a Community of Practice

In contrast to the psychological theories of identity, we propose to take a sociological approach in which we consider how students interact with their social environment and how the two elements, the individual and the mutually constitutive of identity. In their extensive work with communities of practice, Lave and Wenger have argued persuasively that learning is a social practice through which we come to know who we are (Lave, 1992; Lave & Wenger, 1991; Wenger, 1998). Rather than see learning as a process that takes place 'within' an individual', Lave and Wenger argue that it is only through social processes and shared experiences that people gain a sense of self and meaning. Lave and Wenger also reposition identity as a function of participation in different communities – they argue that people do not have one identity, but different identities that are more or less salient in different situations. Thus identity is not represented as stable, consistent or life long but *dynamic* and *situated*. Through their works, they have systematically explored the intersection of community, practice, meaning and identity. For us, this seems to be a more productive means through which we can come to understand not only how students come to learn mathematics, but more broadly in that through participating in the community of practice – in this case mathematics – that they come to learn mathematics and a sense of who they are as learners within the social practice of mathematics.

Through studying how students learn about mathematics, they also learn how to make sense of learning mathematics and sense of themselves. In his study of claims officers, Wenger (1998) argued that:

> They learn how not to learn and keep their shoulders bent and their fingers busy, to follow the rules and ignore the rules. They learn how to engage and disengage, accept and resist, as well as how to keep a sense of themselves in spite of the status of their occupation. They learn how to weave together their work and private lives. They learn how to find little joys and how to deal with being depressed. What they learn and don't learn makes sense only as part of an identity, which is as big as the world and as small as their computer screens, and which subsumes the skills they acquire and gives them meaning. They become claims processors. (pp. 40-41, emphasis in original)

We would argue that the same can be said for students of mathematics. As they are compelled to sit in a mathematics classroom for a significant period of their school life, they come to learn how to participate in that context – they learn when to respond, when to resist, how to appear busy but avoid work. They learn how to cope with the embarrassment, the joy, the cajoling. They learn how the actions in the classroom have meaning and how some of the actions of teachers, texts and students take on substantially different meanings for themselves and others. They learn how to *be* a mathematics student. They develop a sense of who they are as learners within this context, a context which may be very different from other subjects within the school context and beyond the school context. The mathematics student that they see themselves to be may be very different from other students in the same classroom. Similarly, the student that they see themselves as in the mathematics classroom, may be very different from the student they see themselves as in other subject classrooms.

Limited studies exist in mathematics education that explore the construction of identity in and through the practices of mathematics (Boaler, in press). Wenger (1998, p. 47) defines practice as a process of doing within a "historical and social context that gives structure and meaning to what we do…[such that] practice is always a social practice." Practices include both the explicit and implicit; what is said and what is left unsaid. It includes language, artefacts, tools, symbols, rules, along with less obvious aspects including unspoken conventions and rules, assumptions and world views. All of these practices come to make up what it is to be a participant and member of a particular community of practice – in this case, a mathematics student.

It is through the practices within a community of practice (ie secondary school mathematics) that students develop a coherent sense of what it is to be a member of that community. Students attempt to make sense of the community, and in so doing, develop a sense of self in relation to that community of practice. For some students, there is a greater synergy and sense of belonging whereas for others, there is a sense of rejection and hence little sense of identity within the community of practice. Like all communities of practice, the mathematics classroom has developed over a period of time—what is perhaps most remarkable about this particular community of practice is how little it has changed in most countries over the last hundred years. For most students, mathematics continues to be a teacher-dominated practice, with a substantial amount of self-directed work undertaken from either a text-book, board work or individual worksheets. It has been heavily reliant on formal pencil-and-paper testing, particularly in the secondary school. Students come to learn what it is to be a mathematics student through these practices. While there have been notable changes over periods of time, there are equally periods where there has been little change thus suggesting that as a community of practice, mathematics is neither fixed nor transitory. Rather, some features are relatively constant, while others can change.

A recent study of the impact of teachers' classroom practices on identity (Reay and Wiliam 1999) examined primary school students' perceptions of themselves and how the teacher's assessment practices were influential in developing a sense of self. They argue that assessment practices are critical in shaping the way that students come to understand who they are within and beyond the confines of their classrooms, providing both explicit and implicit feedback to students as to their potential to become a member of this community. However, the information is not taken 'at face value'. Instead, students *negotiate* an identity within that community of. In American studies of assessment effects, Donald (1985) posits that assessment practices feed directly in the construction of a range of subjectivity in an insidious manner so as to appear to be a normal and natural process.

In this paper, we examine the practices of secondary school mathematics teaching from the perspectives of the students in order to understand how they construct a sense of themselves in relation to mathematics. In mathematics classrooms, students learn more than the mathematics—they learn what it is like to *be* a member of that community of practice, and whether or not they want to become participants. Learning is a social activity which encompasses the relations between people and knowing. The 'old timers' (the teachers) through their actions and talk convey a sense of what it is to be a member of this community of practice. This can be in terms of the ways in which one works mathematically, how one talks and how one presents to outsiders. Newcomers (students) observe and evaluate the actions of their teachers and the practices within the discipline and decide – either consciously or unconsciously – whether or not they want to become members of this community. This paper explores how students come to make sense of who they are as learners in relation to the community of practice of mathematics students.

Method

The data reported in this paper comes mainly from two studies. In the first, from the United States, one of the us (JB) interviewed 48 students in Advanced Placement (AP) calculus classes in 6 Northern Californian public schools in order to investigate the nature of confidence in mathematics. In the second, from the United Kingdom, 72 students from six schools were interviewed about a range of issues related to their mathematics classrooms (see Boaler, Wiliam & Brown, 2000 for further details).

The Mathematics Classroom Environment.

The students were asked to describe their mathematics lessons, and interviewers engaged students in conversation about the different features they described. The students in the two countries reported a sequence of pedagogical practices that was remarkably consistent. This may be characterised by the following students' description:

> Basically, throughout my experience, we go to class and the teachers lecture, go over the material and show us exactly how to do the problems, cover the subjects that they're teaching and after the teacher's finished teaching if we ask questions and sort of like clear up anything that we don't know and then homework will be assigned to us that day then we go home and do it. (Brad, Cherry school[1])

The students all described teachers reviewing homework, explaining methods at the board and assigning questions to students. Students of two of the US teachers, both women, at Grape and Orange high schools, said that they were encouraged to work on questions collaboratively. Students of the other four US teachers described mathematics classes as individual environments in which they received few opportunities to discuss work.

The mathematics textbooks in the US schools all presented the fundamental theorem of calculus, expanded upon the different concepts underlying the domain and demonstrated procedures that could be used to solve problems. Students would then be led through a series of questions that required them to practice the different procedures. In four of the US schools (Apple, Lemon, Lime & Cherry) and four of the UK schools (Alder, Fir, Redwood and Willow) teachers asked students to practice textbook procedures for a large part of each lesson. In the other two US schools, (Grape and Orange) students spent lesson time discussing the different questions, as a class, and in student groups, while in one of the other two UK classes (Cedar) students worked in small groups, and in the other (Hazel), they worked mainly individually on a series of activities programmed by the teacher

The students' reported beliefs about the nature of mathematics and learning varied according to the extent of mathematical discussion in their classes, with students from the two US discussion-based classes presenting a completely different perspective on mathematics and learning. In the four US schools that encouraged individual work, the 32 students unanimously described mathematics as a procedural, rule-bound subject, and this view was shared by most of the students in the UK schools. These views were held irrespective of gender, confidence levels and prior levels of attainment. Students described mathematics as absolute, concrete and always having one right answer:

> There's only one right answer and you can, it's not subject to your own interpretation or anything it's always in the back of the book right there, if you can't get it you're stuck. (Susan, Cherry school)

> There's definitely a right answer to it. The other subjects like English and stuff that really have no right answer so I have to think about it. (Kim, Apple school)

> In the English I was relaxed, maths I wasn't at all. It's just like, cause there's always got to a definite answer, it's not so much opinions and stuff. It's not any opinion, so I felt a bit more pressure to do well in that, and everyone was saying like 'it's so useful' and it's what at job interviews they're always going to look for, so… (Jane, Firtree school)

> It's because maths is different from other subjects. You have to know the facts and remember them, […] remember the rules and stuff, remember which way goes that way and there's just a lot to remember. (Fiona, Willow School)

> It's all about the formulas. If you know how to use it then you've got it made. Even if you don't quite understand the concept, if you're able to figure out all the parts of the formula, if you have the formula then you can do it. (Lori, Lime school)

> I used to enjoy it, but I don't enjoy it any more because I don't understand it. I don't understand what I'm doing, so if I was to move down [to a lower 'set'] I probably would enjoy it. But I enjoy it when I can actually do it, but when I don't understand it I just get really annoyed with it. (Alison, Firtree school)

> S: It's the only class, where there will be a right or wrong answer, there's a way to get the right answer.

C: I see it more as procedures and solving one problem at a time. It's hard for me to see how it relates to everyday things, so I don't really get the big picture a lot of the time. (Susanna & Cathy, Lemon school)

You have to memorize these little steps, there's always an equation to solve something and you have to memorize stuff in the equation to get the answer and there's like a lot of different procedures. (Vicky, Lime school)

The students in the four US schools and the six UK schools presented a remarkably consistent picture of their classroom experiences as working through problems with one, non-negotiable answer and they concomitantly regarded mathematics as a series of procedures that needed to be learned. Many of the students regarded the exclusive act of practising procedures as inconsistent with the development of a broader, conceptual understanding.

In contrast, the students in Grape and Orange school used the same, or similar, textbooks as students in the other four schools but they did not work through the exercises producing answers that were supported or invalidated by the teacher. Instead they were asked to discuss the different questions, and consider the meaning of possible solutions with each other. This act of negotiation and interpretation meant that mathematics did not appear to the students to be an abstract, closed and procedural domain, but a field of inquiry that they could discuss and explore. Thus the students developed very different views about the nature of mathematics and learning:

M: I don’t know, it just seems like math is more important. In my English class, I can just kind of flow, and whatever’s going on, write an essay about whatever, it’s not a lot, well, in my case, it’s not a lot of deep thinking. Not a lot under the surface.

Int: Is there in math – deep thinking?

M: Yeah. Yeah because the thing, being conceptual, and that’s a lot harder than just like memorizing formulas, definitely. (Melissa, Grape school)

When students were encouraged to discuss the meaning of the procedures they encountered in mathematics, they appeared to develop profoundly different perceptions about the nature of mathematics, and a greater propensity to strive towards conceptual understanding. The students’ enjoyment of mathematics was largely related to the extent to which they identified as a mathematics learner (Boaler, 1999); their perceptions of the subject were strongly linked to these.

Enjoyment and Identification.

Most students in the US schools, despite being relatively successful mathematics learners, reported disliking mathematics, not because the procedural nature denied them access to understanding, although that was important, but because their perceptions of the subject as abstract, absolute and procedural conflicted with their notions of self, of who they wanted to For example:

> Well it's not that I don't understand it, when I understand concepts I like doing it because it's fun. I'm more of a language/history person, kind of and sometimes the things he explains I find really hard to understand. And later, even when they try to ask for help, I get so confused so I don't really like that aspect of it and also there's only one right answer and you can, it's not subject to your own interpretation or anything. (Susan, Cherry school)
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> I'm more of a visual art kind of person, so I always like stuff that was more logic, rather than straight math. Oh, yeah, my dad did this thing back in elementary school, family math, there was a night where it was like parents could come with their kids to the library at school, it was more like little games, little puzzle-type things, but it was fun. I thought it was fun. Back in 4th grade. I enjoyed that. (Amy, Lime school)
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> Int: Do you like math?
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> V: No, I hate it.
>
> Int: Why do you hate it?
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> V: It's just too, I'm into the history, English (…) It's like too logical for me, it always has to be one answer, you can't get anything else BUT that answer. (Vicky, Lime school)
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> I used to love math, but now I think, it's like I'm going to make sure that I don't major in math or anything because it's starting to be like too much competition, it's so weird. When it came to calculus and precalculus, I just kind of lost interest. It's like I'm going to do this for the points, I don't really care. I care more about science and English, stuff that makes sense to me where I think I'm learning morals and lessons from this, where I can apply it to something. (Betsy, Apple school)
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> Int: Why wouldn't you major in math?
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> C: I think I'm a more creative person, I can do it and I can understand it but it's not something I could do for the rest of my life and I think if I had a job I'd like one that let me be a little more creative.
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> Int: Math isn't creative…?
>
> 2: No. (Cathy, Lemon school)
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> I think women, being that they're more emotional, are more emotionally involved and math is more like concrete, it's so "it's that and that's it." Women are more, they want to explore stuff and that's life kind of like and I think that's why I like English and science, I'm more interested in like phenomena and nature and animals and I'm just not interested in just you give me a formula, I'm supposed to memorize the answer, apply it and that's it. (Kristina, Apple school)
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> T: There's definitely a certain type of person who's better at math. Generally, if you're better at English they seem to be more social. And the math people. I don't know, they're just as social, but in a different way. They express themselves differently, they like to see things in black and white. They don't see the colors and greys between. With English people they like things that don't necessarily have an answer. They like to explore that. (Tom, Lemon school)

It seems interesting that so many of the students related their rejection of mathematics to the type of person they believed themselves to be. The students above variously described themselves as a 'language/history, visual arts, history/English, creative, emotional or social' *person*. They did not discuss their choice of subject in cognitive terms, detached from broader notions of identity – yet such notions have pervaded theories of learning and discussions of subject choice. The students' comments suggest that procedural presentations of mathematics do not only make the subject less enjoyable, or preclude understanding for some, they a represent a potential life path that is uninviting for most students.

These attitudes did not come through so strongly from the UK students. Of course, as might be expected, there were many students who disliked mathematics—some with real intensity (see Boaler, Wiliam & Brown, 2000). On the other hand, there were many students who *did* like mathematics but very few of the students who liked the mathematics identified *with* the mathematics—their reasons for liking mathematics were primarily related to their perceptions of being good at it, or because it would lead to a desired further stage of education or employment. The following quotation is typical:

DW: Do you ever work hard on something just because you are interested in it?

C: Yeah, but not in maths. (Colin, Redwood school)

Mathematics was seen as a necessary price to pay for educational or vocational progress, and this was more or less burdensome depending on how easy one found the mathematics. However, even these successful learners did not see the 'ideal' student that their teachers seemed to have in mind as in any way relevant to their own developing identities.

S: They expect us to be like, just doing it straight away.

M: Like we're robots. (Simon & Mitch, Alder school)

He explains it as if we're maths teachers. He explains it like really complex kind of thing, and I don't get most of the stuff. (Paul, Redwood school)

Yeah, I don't know when we use algebra, I don't know when that comes in. I just think it's to see how our brain works, that's all, our knowledge. It never comes in to anything though (Alwyn, Willow school)

Discussion

It is our contention that any explanation of what happens in mathematics classrooms will be incomplete if it ignores the essentially social nature of schooling. The students who are learning mathematics in secondary schools are also trying to negotiate conflicting constraints in developing their identities as sons or daughters, as males or females, as members of various friendship groups and of course, as learners. Most students want to be successful at school, not least to avoid conflict with parents, but they also need to negotiate a way of being successful that does not alienate them from groups with whom they feel affinity. In some cases, the playing out of these social process will lead students *towards* particular individuals or groups, while in others, it will be influenced by a desire *not* to be like an individual or a group. The extracts from interviews described above, and the many more that we could have selected, show clearly that mathematics classrooms in the United States and the United Kingdom present to the apprentice an unambiguous vision of what it means to be successful at mathematics, and of what it means to be a mathematician. However, it is also clear that this vision is one with which many, if not most, students find it hard or impossible to identify. They want to be successful at mathematics (so that they can get on to the next phase of education, or into a job they want), they may even like some parts of the mathematics they do, but they don't want to be successful *as mathematicians*. 'Becoming a mathematician' seems to play no part in their plans. From a psychological perspective this might well be cast as a problem of the 'ability' of the students. However, we believe that more useful insights into the nature of mathematics education, particularly of the 'able' students who are qualified to study mathematics further but choose not to do so, would be gained by looking at this as an issue not of 'ability' but of 'belonging'.

Changing the emphasis from 'ability' to 'belonging' also demythologises the special status of mathematics. The idea of 'belonging' immediately raises the question of 'belonging to what?', allowing the possibility of multiple communities of practice, rather than a single monolithic edifice. This will have particular importance for those practitioners who are keen to develop perspectives on mathematics that are consistent with a view of knowing as 'connected' to human existence, in contrast to the prevailing view of mathematics as 'separate', abstract, remote and 'alien' (Boaler, in press)

Adopting such multiple perspectives would also suggest a redefinition in the way we look at 'success' and 'failure' in mathematics classrooms—the kinds of strategies adopting by teachers in the face of a student's 'failure to belong' would be very different from those suggested by a 'failure of ability'. It would also suggest a move from a view that the 'problem' lies with those who cannot identify with mathematics as presented in school, and instead to a concern with why anyone would be, and would want to be, successful at, something as abstract and dehumanised as the traditional diet of secondary school mathematics.

Notes

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[1] All names of schools and students are, of course, pseudonyms. The US schools are named after fruit, and the UK schools are named after trees.