Mathematics from Another World: Traditional Communities and the Alienation of Learners

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This article reports upon a study of students learning mathematics in six English schools. Interviews with 76 students from the schools are analyzed in order to understand the nature of the classroom communities in which students work; the students’ perceptions of these communities, and the impact of their perceptions upon knowledge development and use. The students in the study reported that social interactions, variety, and meaning were central to positive learning experiences, yet dominant school practices they experienced were memorization, reproduction of procedures, and individualized work. It is argued that teaching and learning practices are central to the knowledge students learn and that those of traditional classrooms are sufficiently strange and other-worldly to create a limiting effect upon students’ use of mathematics in non-classroom situations.

1. INTRODUCTION

Psychological theories of learning have been dominant within mathematics education since its inception as a research domain. But we are now, as Resnick (1991) has claimed, in the midst of attempts to merge the social and the cognitive (Schoenfeld, 1999). Increasingly, researchers are drawing upon anthropological, sociological, and other disciplinary perspectives (Watson, 1998) in their work, thus bringing what Davis (1997, p. 2) described as “other forms of human thought...to bear upon efforts to understand the teaching and learning of mathematics.” Situated perspectives on learning have made a particularly significant contribution over recent years, presenting knowledge, not as a stable, individual characteristic, but something that is distributed between people and the activities and systems of their environment (Brandsford et al., 2000; Lave, 1988, 1996). Learning, in the situated perspective, becomes a process of changing participation in changing communities of practice (Lave & Wenger, 1991) and a person’s knowledge-ability is regarded to be a function of the environments in which he or she operates. Such perspectives allow for knowledge variance between contexts and situations, which many researchers have observed to be characteristic of human behavior (Lave, 1988; McDermott, 1993; Säljö & Wyndhamn, 1993). Within mathematics education, the classroom community, including the implicit and explicit norms and practices that prevail, becomes extremely important, not as a vehicle for learning, but as an intrinsic
part of the knowledge that is generated and used. Part of my aim in this article is to examine the nature of classroom communities, from a situated perspective, and to consider the implications of traditional teaching and learning practices for students’ learning of mathematics.

Traditional teaching practices appear to be based upon assumptions of knowledge independence and stability, which lead to expectations of unproblematic knowledge transfer (Greeno, Smith, & Moore, 1993; Lave, 1988). When teachers encourage students to spend their time in mathematics classrooms practicing standard procedures, this often reflects an assumption that such procedures will be internalized and ready for general use elsewhere, such as the examination hall and the workplace. A number of studies have now demonstrated that such transfer is extremely rare, as new situations provide a whole nexus of structuring relations with which people engage (Lave, 1988). Thus, even when students learn mathematical ideas in the classroom, if their engagement in practices of interaction, adaptation, and reflection were absent, their learning is likely to be of little use in situations that require such practices (Boaler, 1997; Greeno & MMAP, 1998). This is because people constitute their knowledge differently in different situations, which is an idea that has been underplayed in many psychological theories of learning. But we are now entering a new era, and mathematics education is changing (Kieran, 1994), partly due to the increasing consensus that “the power of the unaided mind is overrated” (Norman, 1993, p. 2). This may be witnessed by the number of studies that have moved beyond the individual as the primary unit of analysis to the communities in which students operate, the relations they form there, and the personal and cultural histories that they bring to their knowing (Boaler, 1997; Brown, Collins, & Duguid, 1989; Cobb, 1994; The Cognition and Technology Group at Vanderbilt, 1990; Watson, 1998).

Theories of situativity may be characterized by their “focus on interactive systems that are larger than the behavior and cognitive processes of an individual agent” (Greeno & MMAP, 1998, pp. 5–6). Students do not just learn methods and processes in mathematics classrooms, they learn to be mathematics learners and their learning of content knowledge cannot be separated from their interactional engagement in the classroom, as the two mutually constitute one another at the time of learning. The importance of this interaction has not been fully recognized in mathematics education, and researchers are only now beginning to realize that the constraints and affordances provided by different settings co-constitute the knowledge students learn (Greeno & MMAP, 1998; Watson, 1998). Thus, mathematics is learned through practice, in the same way that an author “does not speak in a given language … but he speaks, as it were, through language” (Bahktin, 1981, pp. 299–300). Wenger (1998) acknowledges the importance of the communities in which students learn and their degrees of affiliation with these, when he proposes that learning is a process of identity formation, and that students locate themselves within particular communities of practice in a process of belonging and ultimately, knowing:

Because learning transforms who we are and what we can do, it is an experience of identity. It is not just an accumulation of skills and information, but a process of becoming—to become a certain person or, conversely, to avoid becoming a certain person. Even the learning that we do entirely by ourselves contributes to making us into a specific kind of person. We accumulate skills and information, not in the abstract as ends in themselves, but in the service of an identity. (Wenger, 1998, p. 215)
Wenger’s theory attempts to provide for the cultural systems, structures, and rules that shape existence, as well as the agency of individuals who are active participants in such systems. Holland, Lachicotte, Skinner, and Cain (1998, pp. 6–7) propose theories of identity and affiliation with a similar aim: “to respect humans as social and cultural creatures and therefore bounded, yet to recognize the processes whereby human collectivities and individuals often move themselves.” Issues of identity, affiliation, and agency place relationships within communities and their impact on knowing center stage, and are crucial to the arguments in this article.

Analyses of the identities that students develop in relation to particular classroom communities may give us considerable insight into students’ knowledge-ability. Many important research studies in mathematics education have analyzed the ways in which classroom environments impact upon students’ learning, generally employing classroom observations (Cobb et al., 1991; Cobb, Wood, Yackel, & Perlwitz, 1992). But theories of identity formation and practice give students an active role in the learning environment, as agents who negotiate, shape, and reflect upon their participation and non-participation. While classroom observations enable researchers to construct representations of school environments, they do not give “voice” (Angier & Povey, 1999) to the student participants in such communities. Yet those researchers who have talked to students in interviews and other conversations have found that “young people are observant, are often capable of analytic and constructive comment, and usually respond well to the responsibility seriously entrusted to them, of helping to identify aspects of schooling that get in the way of their learning” (Ruddock, Chaplain, & Wallace, 1996, p. 8). In this article, I shall take the idea that knowing and doing are inseparable and that mathematical knowledge is constituted by classroom practices and I shall consider what it means for students of mathematics. I shall not argue or provide evidence for this position, as I have done elsewhere (Boaler, 1997, 1998, 2000), but use it as a lens (Lerman, 1998) through which in-depth interviews with students can be analyzed. My aim in doing so will be to consider two questions: how do students view the world of the school mathematics classroom? and what impact do such views have upon knowledge production and use? Constructivist theories of learning have claimed that the social world mediates knowledge (Anthony, 1996; Cobb et al., 1992; Lerman, 1996), but situated perspectives challenge the separation of knowledge and the world implied by such statements, purporting instead that knowledge is co-produced by the social world. At first glance, the distinction between such positions appears small, but I shall argue in this article that the union of knowledge and activity central to situated theories provides the greatest challenge to traditional models of teaching that has ever been made.

2. RESEARCH METHODS

The data that will be reported here are part of a 4-year study of students learning mathematics in six schools in the Greater London area of England. Approximately 1,000 students are being monitored as they move from year 8 to year 11 (ages 12–16). The focus of the study is the impact of different teaching methods and ability grouping practices upon students’ perspectives on the mathematics classroom, and their subsequent attainment. The six schools were chosen partly to provide a range of student intakes. The schools are
located in five different local education authorities. In one of the schools, students are
mainly white, while the other five schools represent a wide range of ethnic and cultural
backgrounds. The performance of the schools in the national school-leaving examination
(the General Certificate of Secondary Education or GCSE) ranges from the upper quartile
to the lower quartile nationally, and the social class of the school populations range from
mainly working class, through schools with nationally representative distributions of social
class, to strongly middle class. One of the schools is an all-girls school and the other five
are mixed-sex schools. All the schools are non-fee-paying comprehensives.

In England, students learn mathematics during every year of their compulsory school-
ing (ages 5–16). Students do not choose mathematics courses in algebra, geometry, or
anything else, as they do in the United States, rather, they are taught mathematics as an
integrated whole. However, the majority of mathematics teachers follow textbooks or
other schemes of work that separate mathematics into different chapters in a rather
disconnected way. The six schools in this study were chosen to reflect different systems of
ability grouping, and while the teaching approaches observed in the schools may be
described as traditional, they are also fairly typical in the UK (Brown, 1996; Gregg, 1995).

In approximately 120 hours of lesson observations of classes in years 8 and 9, the
dominant teaching model observed was one of demonstration and practice, with students
working through short, closed questions in books or cards for most of each lesson. All six
schools teach mathematics to mixed-ability groups when students are in year 7 (age 11).
One of the schools puts students into ability groups for mathematics at the beginning of
year 8 (age 12), three others put the students into ability groups at the beginning of year 9
(age 13), the other two put students into ability groups at the beginning of year 10 (age
14). At the time of collecting this data, all students had just completed the end of year 9,
which had meant a change from heterogeneous to homogeneous grouping for three of the
cohorts. Research methods have included approximately 120 hours of lesson observations
of the cohorts during years 8 and 9, distributed evenly between the six schools,
questionnaires given to students in the six cohorts, and in-depth interviews with 76 of
the students at the end of year 9. Students were interviewed in single-sex pairs. This
included four students each from a high, middle, and low group in the schools that used
ability grouping and students from a comparable range of attainment in the mixed-ability
schools. This article will focus upon the 76 students’ 30 minute interviews, in particular,
the students’ views of their school mathematics environments that were communicated
through these, which will be considered alongside my own awareness of the students’
environments, gained from lesson observations and questionnaires.

During the interview, the students were asked, among other things, to describe
mathematics lessons and what they liked and disliked about mathematics lessons, cite
particularly good and bad lessons, and compare their current experiences of mathematics
lessons with experiences in previous years. In most cases, the same questions were asked
of students, but as interviews were open, allowing the interviewer to respond to issues that
the students raised as important, some questions were not asked of all students. The lesson
observations and interviews with students were coded, using a process of open coding
(Glaser & Strauss, 1967), and the codes were then combined to produce broader themes.
The themes can therefore be thought of as emerging from the data, rather than being
imposed from the outside, reflecting a general commitment to the development of
grounded theory (Glaser & Strauss, 1967).
3. RESEARCH RESULTS

A number of particular issues and broader themes emerged from the interviews that the students described as significant to their learning of mathematics. This article will concentrate upon the three most dominant and recurrent themes that characterized students’ views of their school mathematics learning environments.

3.1. Theme 1: Monotony

In the UK, mathematics teaching is characterized by a strict adherence to a particular scheme, with a scheme usually comprising a series of mathematics textbooks or workcards. All six of the schools that are being studied rely upon their particular scheme to a large extent, with at least 90 percent of lessons in all schools following the set scheme. In approximately 120 hours of observations, researchers observed students working through books or cards, with no practical, investigational, or group work; although students did report that they were given occasional investigations or open-ended tasks each term.

At the beginning of the interviews, all the pairs of students were asked to describe their mathematics lessons. A total of 52 of the 76 students immediately communicated the lack of variety they experienced, with words like “just” and “every” being used in almost all the student descriptions, for example, “we just work through books every lesson.” Sixty of the students were also asked if they could describe a lesson that was particularly good, a lesson that stood out for them as being enjoyable. Twenty-two of the students simply answered that they could not. Two students laughed at the suggestion that a mathematics lesson could be particularly good; one said that she would have to “have a really long, hard think” and most explained that they could not think of such a lesson because mathematics lessons were “all the same.” Eighteen of the thirty-eight students, who could think of a good lesson, chose one in which they had abandoned their normal work and completed a project or investigation. Six students chose lessons when they “didn’t do any work,” eight students chose lessons by the same teacher who was popular, mainly because he used a variety of approaches. Only three students chose lessons involving the books or workcards that they used in the vast majority of their lessons. Examples of typical student descriptions from three of the schools are given below:

P: Every day we was copying off the board and just doing the next page or the next page or the next page and it gets really boring. (Paula, School A).
I: The lessons can be a bit tedious, the same thing every lesson.
J: Just the same thing for weeks on end. (Isaak and Jake, School F).
N: I know I can get high if I want to, if I pushed as hard as I can to get up there, but it’s not easy when you’re doing the same things over and over again. (Nelly, School R).

When students were asked to describe subjects that they particularly liked or that contrasted with mathematics, many of their descriptions centered upon variety:

N: Well in other subjects, like in English we do actual stories, it’s not the same thing on and on. One week we do stories and the other week we have to answer questions about it and stuff. It’s different. (Nassima, School H).
I: For instance, in English you are doing different topics, like once we did Shakespeare, now we are doing like a magazine and stuff like that. (Ishak, School F).

The monotonous nature of school mathematics lessons was an important, distinguishing feature of mathematics for the students, which differentiated mathematics lessons from other lessons in the six schools. This carries obvious implications for the students’ enjoyment of mathematics, and the likelihood that they will continue to study mathematics in later years, but monotony is also a particular feature that contributes towards students’ perceptions of the school mathematics environment, the significance of which will be discussed shortly.

There is a widespread awareness among mathematics teachers in the UK that investigations, applied problems, practical work, and group work are useful experiences for students. However, such activities are regarded by many to be something of a luxury that may be employed in addition to the standard practice of learning and reproducing procedures—if there is time. Thus, many teachers will introduce an investigation at the end of a topic or a term, reflecting the idea that students should learn mathematical procedures, and then be asked to apply them at a later date. Mathematics teaching has not evolved as a subject that involves careful lesson planning. Few teachers of mathematics focus upon the concepts and ideas they want to introduce and then select appropriate activities that would help students learn about the ideas. Instead, they use the textbook as a structuring resource, following the pages of the book in a dedicated fashion, occasionally supplementing the book with an activity or investigation. Group work is rare in mathematics classrooms, probably because it involves a substantial loss of teacher control and the creation of noisy, discursive environments that challenge pervasive ideas about productivity. Cheek and Castle (1981, p. 264) have questioned whether the term “back-to-basics” can be applied to mathematics education, when evidence shows that a basic approach has never been abandoned by the majority of mathematics teachers. They point to research that showed that mathematics instruction had changed very little in a 25-year period “despite the innovations advocated.” The practices observed in the mathematics classrooms of the six schools in this study add support to this claim, even though the six schools were chosen as typical London schools and could not be regarded as unusually traditional. Indeed, the six schools, along with many other schools in the UK, were following a model of mathematics teaching that has repeatedly been encouraged by Government ministers and official school inspectors (Department for Education and Employment, 1997). The student reflections on this demonstration and practice model of teaching suggest that the uniformity that is central to the approach had both a negative and pervasive impact on their knowing.

3.2. Theme 2: Lack of Meaning

Many students who experience traditional models of teaching regard the purpose of mathematics lessons to be the memorization of procedures (Boaler, 1997; Schoenfeld, 1985). Teachers of mathematics introduce methods and procedures to students in the hope that students will learn and understand the procedures, as well as link the different procedures to the broader mathematical domain. But, as Mason (1989, p. 29) points out, this does not always happen: “To the teacher they are examples of some
good idea, technique, principle or theorem. To students they simply are. They are not examples until they reach examplehood.” It is my experience that teachers rarely regard mathematics as a subject that involves a lot of memorization, whereas students often do, revealing a distinction between the teachers’ intention to demonstrate examples of a broader phenomenon, and the students’ inclination to view the examples as facts to be learned:

F: It’s because math 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, School W).

At the end of year 9, students were given a questionnaire \((n = 972)\), which included the question: “When you are approaching a math question, is it more important to think hard about the question or remember similar work you have done before?” Fifty-seven percent of the students prioritized memory over thought (the six schools produced a range of 50% to 61% of students prioritizing memory over thought). This result is consistent with a finding from the Third International Mathematics and Science Study (TIMSS), in which 45 percent of English 13-year-olds reported that memorizing textbooks was the key to success in mathematics (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997). Such views and associated practices are unlikely to help students when they discover, often too late (Boaler, 1997), that examinations generally require more than the reproduction of learned procedures; they require students to choose the correct procedure, and apply what they have learned to new situations.

Many of the students we interviewed were not only struck by the amount of rules and procedures they had to learn, but the meaningless nature of the content. Indeed, many of the student descriptions conveyed a sense of alienation from their work, which students variously described as strange, foreign, and “weird.” For example:

A: It’s because there are so many equations and stuff.
L: It’s hard and it’s boring.
JB: It’s different to other subjects then?
A and L: Yeah.
L: Some of the questions are so hard and so weird. (Aisha and Lena, School W).
C: I look at it right, and it looks like Greek on the page sometimes and it’s like, what?! (Cheryl, School C).

Conversely, when students talked about subjects they liked, they often related their preferences to the meaning the subjects held, and their relationship with the World:

H: Science is just . . . you just learn about normal things in life, that you don’t really know, like energy. Energy and stuff and acids and all that, stuff in your own homes. (Harnack, School W).
P: (In geography) you learn about people and places and you get to research and stuff—researching places, statistics from countries, and things. (Peter, School H).
C: History is like learning what happened in the past and how it’s affected us now. (Charlie, School W).
The students’ reflections on subjects they enjoyed focused on the ways the different subjects related to “normal things in life,” people, places, and events in which they could find meaning. Relating mathematics to events in students’ lives is one way of providing meaning, but there are many others, as Dewey (1938) aptly commented: “To grasp the meaning of a thing, an event or a situation is to see it in relation to other things; to note how it operates or functions, what consequences follow from it; what causes it, what uses it can be put to.” There are many ways in which the kind of relational understanding (Lave, 1996) to which Dewey alluded, may be encouraged, including the use of open, realistic problems (Boaler, 1997), the adoption of an ethnomathematical perspective (Powell & Frankenstein, 1997), encouragement of discussion and argument (Wood, 1999), and exploration of the links and patterns that are central to mathematics. In the following, Wertheim (1997, p. 3) offers an insightful example of the latter:

When I was ten years old I had what can only be described as a mystical experience. It came during a maths class. We were learning about circles, and to his eternal credit our teacher, Mr. Marshall, let us discover for ourselves the secret of this unique shape: the number known as pi. Almost everything you want to say about circles can be said in terms of pi, and it seemed to me in my childhood innocence that a great treasure of the universe had been revealed. Everywhere I looked I saw circles, and at the heart of every one of them was this mysterious number... It was as if someone had lifted a veil and shown me a glimpse of a marvelous realm beyond the one I experienced with my senses.

The students interviewed in this study did not talk about the opportunities they received to discover mathematical “secrets”; conversely, they reported that occasions for meaning development were few and far between. The students talked about working hard in other subjects because they were genuinely interested in the content of the subjects. Those students who were motivated in mathematics seemed only to be inspired by the prospect of gaining correct answers. None of the students’ descriptions of mathematics gave any indication that the students were encouraged to appreciate the beauty of the subject (Wertheim, 1997), the creativity possible in the exploration of problems (Burton, 1999), or the links between mathematics and life:

DW: Do you ever work hard on something just because you are interested in it?
C: Yeah, but not in maths. (Colin, School R).

The distance between the world of school mathematics and anything that was meaningful or real for the students carries obvious implications for students’ enjoyment of mathematics, but the students’ perceptions also convey the esotericism of the school mathematics community within which they were required to operate. Being good at mathematics in such a community appeared to some students to involve being less than human:

M: Like we are robots. All we want to do is work like. But in the other classes it’s different ... I just hate maths. I can’t stand it no more. (Mitch, School A).

If learning is considered to be a cognitive activity, influenced, but not fundamentally constituted by practices, then the remote and esoteric nature of the school environment
may be a hindrance. However, if “expertise, salience, and identification co-develop in an interrelated process” (Holland et al., 1998, p. 122), then environments that preclude meaning for students will stand as significant barriers to their knowing. This point is illustrated by some of the students’ responses when they were asked if they could see any links between the mathematics of the classroom and the rest of their lives. Thirty of the forty-two students asked were adamant that they could not:

S: It’s got no connection. It’s just something to make you think. (Suthida, School C).
R: Most of the time I think—I think, what’s the point? I’m never gonna need it. Learning all these formulas and all this, when you won’t need it. (Ruby, School C).
C: I know that I’ll never really need maths in my later life. (Clare, School F).
A: Hardly ever see why we are being taught it, but I never say, because you always know the teacher is going to say that it will come in useful. (Angela, School H).
M: I just think I am never going to see this again . . . you look at some things and you think—I am never going to see this again, so what is the point? (Moynur, School H).
A: You learn stuff that you think, oh God, what am I going to do with this? Why am I learning this? (Amy, School C).

Questions such as “why am I learning this?” and “what am I going to do with this?” and perceptions that “I am never going to see this again” must surely stand in the way of affiliation and identification. The students interviewed in this study were not chosen because they were particularly disaffected or low attaining; they were chosen, usually by their teachers, to represent a range of attainment. But the students made their feelings about the remote and meaningless nature of school mathematics very clear, suggesting that their engagement, affiliation, and mathematical knowing had been impacted in a non-trivial way. Indeed, the students’ reflections convey an important lack of human agency, which had left many of the students as “outsiders” (Brandsford et al, 2000, p. 6) in relation to the knowledge produced in the mathematics classroom.

### 3.3. Theme 3: The Individual Learner

Students in the UK are put into form groups at the beginning of secondary school. These groups come together for registration each day and are taught together for most subject lessons. Mathematics departments generally operate a system of ability grouping, which involves taking the students out of their form groups and putting them into ability groups for mathematics (called “sets” in the UK). The number of different sets that are formed varies between schools, but it is common for a school to have between four and eight mathematics sets in each year group, which are taught work at different levels and prepared for different levels of examination. When grouping decisions are made, based upon perceptions of ability or some other factor, they reflect an assumption that groups are made up of separate individuals, and that relationships between students have minimal impact upon their learning. Yet many of the students interviewed cited their relations with other members of the group as the single most important factor influencing their predilection towards mathematics. Four of the six schools in our study had recently changed the grouping of students, with students moving from heterogeneous form groups, to homogeneous sets. This meant a change in teacher and teaching method, as well as level
of work, for the majority of students. Seventy of the students were asked whether they preferred working in form groups or setted groups. Fifty-one (73%) chose form groups, 19 (27%) chose setted (11 of these students came from intermediate groups, neither high nor low groups were popular with students—see also Boaler, 1997). What was particularly significant for this analysis was that 31 of the students cited the relationships they had formed within groups as the main reason for their preference:

N: Some people, they don’t like see what set they are in, they see what people are in their class. (Nigel, School R).

The value that students placed upon their relationships with classmates, for their learning of mathematics, was an unexpected outcome of the research and not something we asked students about in interviews, yet it was an issue to which many students drew our attention:

A: I prefer being with my class because you know everyone and you get on with more people. In this class you don’t know everyone and it’s difficult. (Aisha, School W).

P: I think it makes us better when we are as a form, because when we are as a form, that is, you learn. Like, if you know that’s like your group of people you don’t feel shy to do anything in front of them or anything. (Paula, School A).

The importance of the relationships formed between students also emerged when students were asked about the way they moved forward in mathematics when they encountered a difficult problem. Forty-five out of the fifty students asked said that they found it more helpful to ask other students for help rather than the teacher. This suggests that the relations formed between students were formative at an important point in their learning, when they needed to learn something new, and possibly experience cognitive conflict. Another indication of the importance of student relationships was revealed when students were asked to describe their favorite lessons. Many of the student descriptions centered upon the rare opportunities they received to work with others:

R: I like the ones when we do experiments, when we are in a group again. So you can work in a group, so if anybody is stuck on anything you can help people and if you are stuck you can ask people for help. (Ruby, School C).

C: Frogs (investigation) was good because everyone was involved.

A: It was fun because everyone like joined in with it and everything. We all had a go with it didn’t we? (Carla and Ann, School R).

Students also described enjoyable lessons as those in which teachers treated them as people, rather than simply learners of mathematics. The students described teachers who made efforts to relate to students and talk about non-work issues occasionally; these were always non-mathematics teachers:

D: Miss Barley (mathematics teacher), I know you are not meant to be familiar with teachers, but she keeps it so far away. Mr. Hughes sort of, not becomes your friend, but becomes, well, and he explains everything, you know? (David, School A).
The students generally relished the opportunities to be children, or human, which were rare in mathematics lessons, but which the students described as important. They talked about enjoying lessons when they were able to relax a little, and chat with each other and the teacher. This was not because they wanted to avoid work, or spend large proportions of time off task, but because they wanted to transform the classroom into a life-like environment. The motive for this did not appear to be to increase their enjoyment, but opportunities for enhanced mathematical understanding.

In McLaughlin’s (1994, p. 9) study of reform schools, students told researchers that “the way teachers treat you as a student—or as a person actually,’ counted more than any other factor in the school setting in determining their attachment to the school.” Angier and Povey (1999, p. 5) conducted an in-depth study of one class of learners with similar results: “When asked to write about or discuss their mathematical learning, the students referred again and again to the social element of their learning. It mattered who the teacher was, it mattered who was in the group, it mattered how the class was organized.” The students in this study expressed similar sentiments, placing their relationships with others and the interactions they experienced as central to their learning of mathematics. Theories of identity and affiliation make sense of the students’ comments as they propose that “an assessment that a culturally interpreted world lacks validity, truth correctness, or rightness may indeed affect whether an individual can conceptualize the system as relevant to herself” (Holland et al., 1998, p. 120). Many of the students’ comments in this study suggest that anti-social environments in which students cannot work together, or even help each other, lack the validity or correctness they need for full engagement. The value students placed upon interactions for their mathematical understanding, extended beyond the opportunities that group work provided for discussion of work, to the nature of the communities in which they were required to work, and the need for identification with those communities, based upon positive relationships with teachers and students.

The significance students place upon their relationships with teachers, and, more importantly, other students, is perhaps unsurprising, given that most adults would probably cite relationships with colleagues as important factors impacting upon job success and satisfaction. The formation of student relationships is, however, a factor that is rarely considered by schools and absent from many analyses of learning. This seems to be particularly significant for mathematics education as the majority of mathematics classrooms in the UK place a premium upon individual work. In the six schools in our study, students were allowed to talk to each other as they worked, but teachers rarely encouraged discussion as a form of mathematical thinking or learning. Some teachers did not allow students to talk, even when they were helping each other:

L: Say this kid’s stuck and we tried to help him, all we’re really doing is trying to help him, we’re just getting in trouble because we’re trying to help kids that don’t understand. It’s just really annoying and off-putting. (Lee, School R).

In this extract, Lee explicitly links the anti-social and uncooperative nature of his classroom environment to disaffection, as well as disaffiliation.

It seems significant that the social relations formed between students, and the discussions they held with each other, were cited by many students as the most important
feature of their learning, yet this social dimension was largely downplayed or ignored in
the schools, by virtue of the mathematics approaches and ability grouping practices
employed. The students located their learning of mathematics within a broad, social
domain, which is entirely consistent with situated perspectives on learning, while the
schools regarded the students as individual learners who could be shifted from group to
group. Corbett and Wilson (1995, p. 16) report that the few studies on school reform that
have given voice to students emerged with the common message that “for students, the
quality of the human relationships they engage in has a lot to say about the value they
attach to their schooling.” Schools have not traditionally regarded student relations as
important to learning, relating student friendship and communication to enjoyment, rather
than knowing. But if learning is regarded as a process of becoming a member of a
particular community of practice (Lave, 1993), then the social interactions that take place
in the classroom, and the relations that form between students, become extremely
important. Paula (school A), as cited earlier, captures this idea well, reflecting that when
she was among her form group, which she knew as her “group of people,” quite simply,
she learned.

Humans are inherently social beings, and interactions with people form the basis for
life’s experiences (Dewey, 1938); this makes the individualistic nature of mathematics
lessons extremely unusual. This may carry significance beyond the fact that students lose
out on the opportunity to discuss work and gain meaning from mathematical discussions.
The individual nature of mathematics classrooms makes them extremely particular and
other-worldly places for students.

4. DISCUSSION AND CONCLUSION

During the coding of interviews with the 76 students, I realized that many of the
students’ concerns could be related to the particular and unusual nature of the
mathematics classroom environment and the difficulties they faced identifying with
such an environment. As my awareness of this idea increased, I began to use it as
a particular lens (Lerman, 1998), through which I examined the students’ ideas
about their learning. This led me to characterize a particular set of practices that the
students described as central to school mathematics—namely, practices of abstrac-
tion, individualism, conformity, and uniformity. Other researchers have highlighted
similar characteristics of mathematics classrooms, for example, Anderson (1997, p.
295) writes that there is a common myth that before one can learn mathematics,
one has to:

1. Separate arithmetic from algebra;
2. Teach mathematics without any historical references;
3. Use textbooks that are elitist and cryptic;
4. Do work and be tested as an individual as opposed to working and being tested as
study groups;
5. Accept the myth that mathematics is pure abstraction and therefore antithetical to
one’s cultural and working environment; and
Anderson offers this classification to illustrate how mathematics classrooms come to alienate all but the elite few, particularly people of color, women, and working class students. It is unclear whether the traditional practices characterized by Anderson, as well as the alienation proposed, are widespread. There are certainly many more positive models of mathematics teaching in schools in the UK (Boaler, 1997), US, and elsewhere (Stigler & Hiebert, 1999). However, the traditional practices Anderson has described were consonant with many of the students’ perspectives from the six schools in this study.

This article is an attempt to consider the activity systems in which students learn mathematics, from the students’ perspectives. By summarizing across a large number of interviews, as well as drawing upon some of the students’ comments, I hope to have provided both an overview of the students’ ideas, and given depth to the images they portray. Research studies always reflect a tension between breadth and depth; in this article, I have sacrificed some of the former by relying upon interviews, and some of the latter, by summarizing the students’ views, but I hope, in doing so, to have retained some ecological validity. Each of the different mathematics classrooms represented by the students’ comments is a system of its own, and a considerable amount of complexity has been lost by my generalization across the different systems. At the same time, it seems that the different classroom systems share some practices, and that becoming more successful mathematics learners depends upon engagement in those practices. The importance of classroom practices has never been questioned, but a situative perspective (Greeno & MMAP, 1998) encourages us to consider these practices, not as vehicles of mathematics content, but as participatory activities that are fundamental to what students learn. Theories of learning identity (Holland et al., 1998; Wenger, 1998) also suggest that we should consider the ways in which students affiliate and engage with these different practices. These two points are both worthy of further consideration.

The students’ representations in this article suggest that dominant school practices in the mathematics classroom are memorization, reproduction of procedures, and individualized work, all of which play a limited role in situations outside the mathematics classroom. A situated perspective on learning does not imply that certain teaching practices are better than others, but it does suggest that the activities of different practices are central to what is learned. Thus, Greeno and MMAP (1998, p. 15) assert that classroom discussions are important, not only as a way of making content meaningful, but because students are learning to participate in discourse practices. Similarly, project work is important as students “develop abilities of collaborative inquiry and of using the concepts and methods of a discipline to solve problems” and representational systems are valuable as they enable students to learn to use and appreciate different systems of representation. Support for this assertion is provided by an in-depth study of students learning mathematics in two schools (Boaler, 1997, 1998, 2000), which showed that students who learned mathematics in a traditional environment found it difficult using their school mathematics in non-classroom settings. They related this difficulty to the fundamental differences between the environments and interactional systems of school and the real world. Students who learned mathematics through discussion-based projects were more able to use mathematics in situations requiring discussion, adaptation, and application. The students who had learned mathematics through traditional methods, in that study, conveyed similar views about the
remote nature of school mathematics to the students interviewed as part of this study. The results of these two studies both suggest that even when students learn a mathematical procedure in school, if the practices that support the procedure are particular to the mathematics classroom, they will find it difficult adapting the procedure they have learned to any other situation.

The second observation raised by situative perspectives concerns the affiliations students develop towards certain learning experiences. Practices of individualized work, memorization, and repetition of formal procedures are not only limited in their usefulness outside the mathematics classroom; they discourage meaning, engagement, and understanding. This suggests limited affiliations and, for many students, complete alienation. It was clear that many of the students interviewed regarded the mathematics classroom as sufficiently strange and other-worldly that learning to be a mathematics learner, involved adopting the identity of a “robot” (Mitch, school A) or, at the very least, someone who could abandon natural human desires to attain meaning and interact socially with others. Rose (1998, p. 4) reflects upon her experiences as a school learner of mathematics, and in doing so, captures the importance of other-worldly perceptions eloquently. She recalls that as a young child, she had been something of “a mathematical wunderkind” and loved to explore patterns, numbers, and shapes, and that her love of mathematics had been stimulated by her experiences in a small, rural school that had no textbooks, but a mathematics teacher with whom students worked with. She goes on to describe how her own sense of mathematical magic ended when she attended an elite girls’ school where mathematics was divided into separate components and she felt that she understood less, rather than more, as the teaching proceeded: “All the excitement and magic was gone. My strongest memory, even now, is of the unattractive aesthetics and stupidity of the textbooks—ugly small type asking stupid questions” (p. 5). Rose describes feeling particularly alienated when “real world” problems were introduced, with which she enthusiastically engaged drawing upon her knowledge of the situations described, only to find that such knowledge was not allowed, and that engagement with the problems involved a step away, rather than towards the real world (Boaler, 1993). Maier (1991) has proposed that school children recognize that school mathematics is not a part of the world outside school, partly because of the artificiality of school problems and Rose (1998, p. 5) offers support for this perspective:

Thinking about it, it was those so-called practical problems that irritated me the most. It was obvious to me that many of the questions simply indicated that the questioner did not know enough about the craft skills involved in real world solutions. Lawn rollers being pulled up slopes, wallpapering rooms by calculating square feet and inches: these were tedious and as far as that highly practical child could see, stupid . . . I know that the price I paid was to lose my sense of confidence that school maths and everyday maths were part of one world.

Rose describes feelings towards secondary school mathematics that many of the students in our study seemed to share. School mathematics, for many of them, was of another world and to fully engage in that world, students needed to suspend their knowledge of the real world, suppress their desire to interact with others, and strive to reproduce standard procedures that held little meaning for them. Theories of identity and affiliation propose that students need to believe in worlds and regard them as valid
and right, before they will conceptualize themselves as part of them, and fully engage with them (Holland et al., 1998). However, a range of studies suggest that the practices I have characterized in this article, that many students regard as strange and other-worldly, are relatively commonplace within mathematics classrooms (Jaworski, 1994; Peterson, 1988; Sigurdson & Olson, 1992). Some students are happy stepping into the school mathematics world, either because they find success there or because it offers a form of shelter or recluse from the interactional demands of real life. But for many students, engaging with such a world requires a serious re-alignment of identity that they are unable or unwilling to make, and research suggests that this is particularly true for girls (Boaler, 1997), working class students (Bernstein, 1975; Bourdieu & Passeron, 1977; Zevenbergen, 1996), and students from non-dominant cultural backgrounds (Burton, 1990). Some students have such strong academic identities and scholarly drive that they will play the school mathematics game and be successful mathematics students, but they only loan themselves to such a world, as soon as they have the chance to leave it, they do so with much relief. Many women and girls belong to this third group, thus inhibiting their career choices to those containing non-mathematical paths. Dreyfus (1984) describes the development of expert knowledge as moving through five stages, from novice to expert. The different stages relate to the degrees of affiliation or involvement that learners have; in the novice stage, knowledge is mediated by rules and maxims, but as students learn more, they develop more agency and responsibility and start to form their own questions and devise moves in response to them. All of the students interviewed appeared to regard themselves as rule-followers rather than active agents, suggesting that they had not moved beyond the novice stage of learning. This is not surprising as traditional systems of school mathematics differ from both the practices of mathematicians and mathematics users in the World (Burton, 1999; Noss, 1994), precisely because of their emphasis upon rule-following and the limited opportunities for agency provided by such systems.

Issues of identity, affiliation, and practice may all be considered within an overarching concept of community (Lave & Wenger, 1991; Louis & Marks, 1998). If the mathematics classroom is viewed as a particular community, with its own set of participants and practices, then it makes sense to consider the environments that are generated within mathematics classrooms, the norms (Cobb et al, 1991, 1992) that prevail there, and the relationships that form between the different actors in the community. For while educators have been focusing upon individual cognitive development, students have been living through communities and the nature of the practices and relationships they have encountered there may well have inhibited their agency, affiliation, and knowing. The following student, taken from Angier and Povey’s (1999, pp. 6–7) study, reflects upon her classes with a reform-oriented teacher, and gives a vivid reminder both of the importance of community perspectives and the differences that such teachers can make:

We all felt like a family in maths. Does that make sense? Even if we weren’t always sending out brotherly/sisterly vibes. Well we got used to each other . . . so we all worked . . . we all knew how to work with each other . . . if there were a new person come into the group they wouldn’t know what we were like . . . because we were in groups we worked together . . . it was a big group . . . more like a neighborhood with loads of different houses.
Students within mathematics classrooms regard themselves as a community, whether teachers do or not, and it is antithetical to the notion of any community that it should inhibit communication between participants, and that dominant practices preclude meaning and agency.

Traditional teaching methods have been challenged on many counts, with suggestions that they are not interesting, and that they give students little opportunity to construct understanding. But situative perspectives add something new and different to the conversation, because they focus upon the classroom processes that define the knowledge that is produced, suggesting that practices of individualized, abstract procedure reproduction “deny students the chance to engage the relevant domain culture” (Brown et al., 1989, p. 34). Neither professional mathematicians (Burton, 1999) nor professional users of mathematics (Noss, 1994) spend their time reproducing standard procedures—that is, a particular practice specific to the mathematics classroom. Yet the specificity of that practice may be the single most important factor reducing achievement and affiliation for students. The suggestion that mathematics teaching approaches should offer varied, realistic constraints, and engage students in discussion and negotiation is far from new, but the situated perspective adds another dimension to such proposals. For if learning mathematics entails more than the construction of cognitive forms, but of changing participation in a range of communities, then a classroom community that lacks the human and worldly qualities of social interaction and meaningful engagement, may bound (Siskin, 1994) students’ knowledge. Thus, it is not the extent of knowledge that is in question, but its accessibility. Classrooms that appear alien, esoteric, or other-worldly to students may simply condemn their mathematical knowledge to nether reaches of their minds, producing learning identities that lack compatibility with any other places.

Learning to be a successful student of mathematics involves learning the rules of the school mathematics game and forming a learning identity that fits with the norms of the classroom community. This is an idea that many psychological perspectives on learning have overlooked, mainly because they have focussed upon individual students, rather than the broader systems in which students learn. But situative perspectives propose that individuals cannot be separated from their communities, and that dualisms of the mind and the World (Bredo, 1994) are artificial constructs. Teachers are constantly giving signals and cues that help students learn the rules of the game (Wood, 1999), and the common practices encouraged by particular textbooks reinforce many of these messages. However, the practices encouraged in mathematics classrooms are not always useful elsewhere. This becomes problematic as soon as we acknowledge that learning is “a social phenomenon, constituted in the experienced, lived-in world” (Lave, 1993, p. 64, italics added). The validity of a situated theory of knowing is still open to question and debate (Anderson, Reder, Simon, 1996), but if there is any accuracy in its central premise, the implications for traditional practices of mathematics education must surely be bleak.

REFERENCES


