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The Social Context of Mathematics Education: Issues to be Addressed

Introduction

Both national and international research developments, and national policy considerations, provided the stimulus for this study. At the national level, research regarding the implications of coeducation stimulated a debate about the possible negative implications for girls attending coeducational schools, particularly in terms of mathematics (Hannan et al. 1996). While the authors found that girls in coeducational schools had lower grades than their single sex counterparts, what was not clear from the study was the extent to which the lower attainment of girls in coeducational schools was a function of the differences in the levels of mathematics (Higher, Ordinary and Foundation) being taken in single sex and coeducational schools. Neither was it possible to determine from a national study of the kind undertaken by Hannan and his colleagues what impact the culture of mathematics classrooms had on learning of mathematics, nor how the practices of individual teachers impacted on learning. The authors suggested that further more in-depth research was necessary to explore these issues.

What the national research suggested therefore was that if we were to understand gender differences in the experience of mathematics education, we needed to study life in classrooms in depth. We needed to see what was happening in educational settings rather than what students and teachers reported was happening. The culture of mathematics classrooms could only be understood by observing and recording these classes, by exploring with teachers and students how they interpreted the lessons, and checking our interpretations with those of the classroom participants.

In the international arena, mathematics education constitutes a major research subject in its own right (Grouws, 1992; Boaler, 2000). Within this context, students are increasingly recognised in their diversity, and gender is one of the defining features of that diversity (Burton, 1995; Fennema and Leder, 1990; Secada, 1995). However, the debate about gender has become more complex as scholars recognise the limitations of unidimensional research focused solely on gender (or race, class or ethnicity) (Secada, 1992). There is a growing recognition that statuses and identities are complex and overlapping and that any research on gender needs to take cognisance of how social class, race, ethnicity, language and other differences impact on learning (ibid).

In addition, there is what Lerman (2000) terms 'a social turn' in mathematics education research. While research on mathematics education had previously been dominated by the disciplines of psychology and mathematics (Kilpatrick, 1992), over the last fifteen years there has been a change in this trend. The growing influence of the work of Vygotsky in particular, has generated an interest in the social context of learning. It has opened mathematics education research to the influences of anthropology, sociology and cultural psychology (Lerman, 2000, p. 25). It is increasingly accepted that learning is not solely a private individual matter; it is a situated and socio-cultural experience. Knowledge has to be understood relationally, between people and settings. Learning is about becoming competent in life settings (Lave and Wenger, 1991). Understanding how students learn therefore is about understanding not only how they experience mathematics but also how the other major players in their educational world, especially teachers and parents, define their learning experience. It is about how individual learners are created in the social and cultural practices of education, and how individuals are agents in the shaping of these practices.

What was clear from international research therefore was that if we were to understand gender differences in the experience of learning mathematics, we could not focus on gender alone. We needed to examine differences that interfaced with gender, including social class, racial, ethnic or other differences.

> Even though gender is often a significant determinant of aspirations, expectations and behaviour, there are many other variables, including race and class for example, which have an important and interactive impact. For future research to incorporate such within-group differences is consistent with the plea already made for a more explicit recognition of individual differences. (Leder, 1992b, p. 617)

Because the experience of learning mathematics is not a private affair, but one that is situated in particular socio-cultural and historical contexts, we also needed to examine how teachers and parents in particular defined the learning process for students in school.

The cumulative outcome of these research considerations led us to design a two phase study. First, we needed to establish whether the differences in attainment for girls attending single sex and coeducational schools, identified by Hannan et al. (1996), held true over time. We also needed to establish whether or not the differences were a function of the type of school attended, or the level at which subjects were being offered across school types. Using Junior Certificate Examination data, gender differences in attainment in the Junior Certificate Examinations were examined over a five-year period. The research focused in particular on the differences in both take-up rates of different levels of mathematics (Foundation, Ordinary and Higher) across schools, and on the differences in attainment rates *within* each level for different types of schools. The period chosen for investigation was 1992 to 1996, as the examination data from these years was the most recent available when the study was planned in 1997/8. The analysis of the national examination data took place prior to the case studies in the schools, as it was believed that the findings from the national data would give a good indication as to what were the most significant factors that needed to be explored in the case studies.

In the light of the findings from the National Junior Certificate study, it became clear that while there were differences between single sex and coeducational schools, these differences appeared to be related to differences across school type, differences in the level of subject offered and differences in school intake. Gender appeared to be a less salient factor in explaining differences in take-up and attainment than social class background. In the light of this, it was decided to undertake an intensive study of the teaching and learning of mathematics in schools that were relatively polarised in terms of social class intake (feepaying and designated disadvantaged schools) as well as schools that varied in terms of their single sex/coeducational status and their management structure. Given that prior research on schools had indicated that track or stream position also impacts on classroom experience, classes were chosen for observation that were either top streams (and taking Higher level mathematics) bottom streams or bands (taking Ordinary and sometimes Foundation level) or mixed (with students taking different level courses within the one class).

The case studies undertaken to analyse the teaching and learning of mathematics were intensive and wide ranging. Ten schools were chosen and one teacher and class was videotaped on two separate lessons in each. The students observed in these classes were also given a detailed questionnaire about their learning experience of mathematics and were interviewed subsequently about their experience. The teachers were also interviewed about their teaching and given the opportunity to comment and suggest changes in our interpretations of their teaching style. A sub-sample of parents of the students surveyed was also interviewed about their children's experiences of schooling and of mathematics in particular.

A triangulated view of the research problem was obtained by dialoguing with all the main parties to the learning process – students, teachers, school principals and parents – by comparing their interpretations of the learning process.

The study employed a co-operative mode of research inquiry with teachers in particular, and to a lesser degree with students. In so far as time and resources permitted, we operated a dialogue with the case study teachers as to the authenticity of our interpretations of their classroom teaching. Two of the ten case study teachers expressed a keen interest in the study; one of these read and commented on drafts of the final text.

What was involved in the research therefore was really a series of studies, designed to understand the complex phenomenon of mathematics teaching and learning. The question was not whether we should use quantitative or qualitative methods but rather how could we better understand the research problem. It involved 'the intelligent use of multiple methods' (McLeod, 1992, p. 591).

The Study of Junior Certificate Examination results

The study of the Junior Certificate Examination over a five-year period revealed a number of important trends in mathematics take-up and performance. First, it was clear that the pattern of take-up in mathematics was quite different to that in other comparable subjects, most especially to that of English and science. While the majority of students taking English and science took these subjects at the Higher level (61 per cent and 69 per cent respectively) only 36 per cent of students took Higher mathematics at the Junior Certificate level. The pattern identified between 1992 and 1996 has persisted up to the present time. In 2000, there were still only 36 per cent of students taking Higher level mathematics nationally, compared with 61 per cent taking Higher English (Department of Education and Science, 2001). The relatively low take-up rates in Higher mathematics is undoubtedly related to the fact that, in 64 per cent of Irish schools, 40 per cent or fewer students were taking the Higher level examinations in 1996. There were a small number of schools (7 per cent) that did not examine mathematics at the Higher level at all, while in 1 per cent of schools students were only examined in Foundation mathematics. The schools with the most disadvantaged students were the ones in which there is the highest take up of Foundation and Ordinary mathematics, and these also tend to be disproportionately vocational schools and community colleges.

Take-up rates do not vary much by gender, although slightly more girls were taking Higher mathematics in 1996 and in 2000. While there were differences between girls and boys in take-up rates, these differences were more a function of the type of schools the students were attending (and by implication their social class background and attainment levels at entry) rather than their gender per se. Both girls and boys in secondary schools were much more likely to be taking Higher mathematics than girls or boys in vocational schools or community colleges. Conversely, the take-up of Foundation level mathematics was especially high in vocational schools and community colleges.

Such differences must be interpreted with caution however, as the profile of students in these schools is quite different, with secondary schools being generally more middle class and more academically selective in intake than all other school types (Hannan et al., 1996). The fact that 43 per cent of vocational schools and community colleges are designated disadvantaged compared with 22 per cent of single sex secondary schools is itself proof of the differences in intake between the two school types.

Within given school types, it was boys in single-sex secondary schools who were most likely to take Higher level mathematics, either compared with girls in this sector, or students of either gender in the other school types. While take-up differences between males and females within the secondary sector were moderate, those between males in single-sex schools and *both* males and females in vocational schools and community colleges, were considerable.

Differences in performance that were identified across school types also need to be interpreted in the light of both intake differences between schools, and the widespread use of grinds (private tutoring) to boost grades. Thus, while students (girls and boys) in single sex schools had higher rates of attainment in mathematics across the years than students in vocational schools and community colleges in particular, these higher rates must be understood in context of the fact that single sex schools are more middle class and less disadvantaged in intake, and also traditionally more directly and indirectly selective (Hannan and Boyle, 1987, 1996; Lynch, 1989). We do not know to what extent Junior Certificate students in different school types receive 'grinds', but the evidence available suggests that they do. It also suggests that it is the relatively economically advantaged who are best positioned to avail of such privately funded tutoring (Lynch and Lodge, 2002).

In terms of gender, while girls, on average, achieved higher scores than boys at each level of mathematics, boys consistently achieved a higher proportion of A grades in Higher level examinations, and this was true across all types of schools with the differences being greatest between girls and boys in comprehensive schools.

An examination of gender differences *within* these school sectors showed that female and male grades were very similar across all three levels, especially when compared with differences across types of schools. The greatest disparities in both take-up and attainment in mathematics were between students in disadvantaged schools, and students in fee-paying schools, not between boys and girls per se. This confirms the findings of Gorard et al. (2001) in Wales and Arnot et al in England and Wales (1998), that gender differences in performance generally are not as great as they have been portrayed to be in the popular media. While recognising the importance of gender difference ‘it is inappropriate to ignore or minimise the substantial variations that exist within groups of males and females’ (Leder, 1992b, p. 616)

Not only did students in disadvantaged schools not achieve as highly as students in non-disadvantaged schools, but the differences identified generally across school types (that is between secondary and other school types) also obtained between schools in the disadvantaged sector, especially for girls. While both girls and boys in disadvantaged community and comprehensive, and in vocational schools and community colleges, had lower rates of attainment generally than their peers in disadvantaged secondary schools (both coeducational and single sex), the disparity between the girls was slightly higher than that between boys. In Higher mathematics, girls in disadvantaged single sex schools achieved the equivalent of a half a grade higher score than girls in disadvantaged vocational schools and community colleges. Girls in disadvantaged coeducational secondary schools also had higher scores than girls in vocational schools and colleges, and than girls in disadvantaged comprehensive and community schools, although the differences were not as pronounced.

In terms of the A grades awarded at Higher level, girls in disadvantaged comprehensive schools, and in vocational schools and community colleges, had lower aggregate grades compared with boys *within* their schools. While the boys in disadvantaged single sex secondary schools also had higher grades than girls in disadvantaged single sex schools, the differences were not as pronounced. At Ordinary level, girls got more A grades in disadvantaged schools in the secondary sector, while the reverse was true in vocational schools and community colleges and in community schools. In addition, while girls in secondary schools got fewer very low grades in Higher and Ordinary mathematics, girls in other schools had a proportion of low grades that were relatively equal to that of boys (Table A2.8, A2.9). The findings suggest that while the performance of both girls and boys are lower in disadvantaged schools outside the secondary sector, the performance of girls within these is somewhat lower than that of boys.

Discussion

The findings from the Junior Certificate study raise a number of important issues both about education generally and mathematics in particular. First, it is evident that the take-up of Higher level mathematics is low by comparison with other Junior Certificate subjects, except for English. There is a need to examine why this is the case. Is it related to the fact that Ireland remains unique in Europe in teaching mathematics (and English and Irish) at three levels for the junior phase of second-level education? (While the UK has two levels, a number of EU countries only teach the subject at one level). It cannot be solely related to this, however, as the three-tier system does not seem to have affected the take-up of Higher English, although the take-up of Higher-level Irish is also low (40 per cent in 1996 and 37 per cent in 2000).

Another hypothesis is that it is related to the culture of teaching and learning that has developed in mathematics, which presents the subject to students as static rather than dynamic, abstract, formal and remote rather than relevant and accessible (Dossey, 1992; Nickson, 1992). Burton suggests that it is not mathematics *per se* that students may be rejecting but the form in which mathematics is presented in schools. School mathematics is often presented didactically and procedurally. As such it does not relate either to the discipline as it is lived in practice, or as it is taught in the university (Burton, 1999a). Rather, in traditional classes, mathematics is perceived as a subject in which 'obedience, compliance, perseverance and frustration' play a central role (Boaler and Greeno, 2000, p. 184). Mathematics can appear to the learner therefore to be alien, lacking conceptual depth and without imagination and creativity (Burton, 1999a). As such, it may not be attracting educationally ambitious students who expect a subject to offer them the opportunities for agency and creativity that is available in other fields (Boaler and Greeno, 2000). School mathematics may not be attractive to students therefore both because of its substantive content, and because of the way it is taught and examined in schools.

A further hypothesis that needs to be explored is the claim that mathematics teachers present Higher mathematics to students as being difficult and only accessible to a select cohort. There may be a perception that only certain types of girls and boys can take Higher mathematics. Research on the images students hold of mathematicians reinforce the view that students regard the subject of mathematics in quite problematic ways, and the images they hold of the subject relate to the way they are treated within it. Research across a number of European countries (UK, Finland, Sweden and Romania) and the US on the images twelve to thirteen year olds hold of mathematics teachers suggests that they are often intimidated in mathematics classes. Students reported being fearful of being criticised for making mistakes in their work, while feeling overpowered by the teachers' knowledge to the point that some students depicted their mathematics teachers as wizards with magic potions! (Picker and Berry, 2001). 'The dominant image of a mathematician that emerged from this study is that of a white, middle-aged, balding or white-haired man' (ibid, p. 55) This points to a gender, racial and age gap in students' images of mathematicians, a finding that concurs with earlier research in school children's image of scientists (Barman, 1999; Chambers, 1983).

A related issue for mathematics educators is the question of the relationship between mathematics and personal identity. Students choose subjects and fields of study, not only because of their intrinsic interest in the field and the perceived utility of the subject, but also because of the profile of the teacher who teaches it. They also choose a subject in terms of how the subject offers them an opportunity to develop a particular educational and social identity. As mathematics is currently taught in many schools across the world, it is presented as a relatively fixed body of knowledge that has to be acquired in a relatively passive manner (Nickson, 1992). The image of the mathematician is that of a received (generally male) knower rather than active agent creating and developing the subject. As Boaler and Greeno observe:

> A large proportion of the students interviewed appeared to reject mathematics because the pedagogical practices with which they had to engage were incompatible with their conceptions of self … these students considered themselves as *constructive** knowers in other schools subjects. They understood themselves as *received** knowers in the limited circumstances of the mathematics classes in which the learning practices available to them required that they acquire specified procedures with no opportunity that they perceived to be thoughtful or creative about what they needed to learn to do (Boaler and Greeno, 2000, p. 186). (*emphasis is ours)

What seems to be happening in many mathematics classes is that students are being turned away from the subject not by their inability to do mathematics, but rather because the substantive content of what is taught in schools, and the pedagogical and examination practices employed, all of which alienate them from the subject (Burton, 1999a, 1999b; Boaler and Greeno, 2000).

Why girls in certain types of disadvantaged schools are not performing as well as girls in other disadvantaged schools, and boys in their own schools, is not easily explained however from within the existing literature. Much more would need to be known about the gender profile of staffing and leadership in these schools, as well as that of mathematics teachers within them. How gender sensitive teachers of mathematics are in their classroom practice would also need to be explored, as would the way in which students construct their personal identities in relation to mathematics. When students reject mathematics their reasons go 'beyond cognitive likes and dislikes to the establishment of their identities' (Boaler and Greeno, 2000, p. 187). Boaler and Greeno found that even high achieving girls rejected mathematics, because it did not give them opportunities to be creative, verbal and humane. There is also a growing body of evidence that suggests that certain classes of girls[1] may become alienated from achieving in school (and by implication in mathematics) because it does not accord with their preconceived, structurally generated, classed and gendered identities (McRobbie, 1978; Skeggs, 1997). As Skeggs (1994, 1997) has observed, many working class girls (and these are the girls who predominate in the disadvantaged non-secondary schools where girls were performing lowly relative to boys, and to girls in other schools) do not identify with the middle class 'civilising' (colonising) project of the school. Their identities are constructed around roles and relationships of caring and earning that are very removed from school mathematics (Mahony and Zmroczek, 1997; Walkerdine and Lucey, 1989). Their poorer performance cannot simply be explained in terms of teaching or school-specific variables, crucial as these may be. It must also be understood in the wider socio-cultural context in which gender identities are created and reinforced.

General research on women's experience of, and attitudes to, mathematics reinforces the importance of pedagogy and identity as key factors in determining their response to the subject. A number of studies have shown that women and girls tend to reject subjects that do not offer opportunities for deep and connected understanding, even though many may view mathematics as a deep subject (Becker, 1995; Burton, 1995). Women opt for subjects that are seen to give opportunities for caring, creativity and expression. Mathematics is frequently not perceived to offer these kinds of opportunities so it is not the kind of subject with which women want to identify (Boaler and Greeno, 2000). In addition, mathematics is a subject in which teachers are seen to be masculine (Picker and Berry, 2001), while the learning environment in mathematics classes has been shown to be experienced by girls more than boys as exposing them to public shame (when shouting out answers is encouraged and students are named as either right or wrong) (Boylan, Lawton and Povey, 2001). The lack of interest that girls and women display in mathematics-related careers therefore needs to be understood in the context of personal and career identities that are prescribed culturally for women and men, and with which women and men identify. How the culture of schooling reinforces or challenges stereotypical gender expectations around mathematics, in terms of pedagogy, assessment and process also needs to be explored.

The reasons why students may not be opting for Higher mathematics therefore are not simple; neither is it clear from the research literature why certain types of girls are not achieving as highly as others. The national and international literature suggests that it may relate to a combination of forces: these include the structure of opportunities in schools; the attitudes of teachers to the subjects; the pedagogical styles in mathematics classrooms (which in turn is related to modes of assessment); and the way in which students comprehend their own identity in terms of mathematics.

The case studies

Traditions die hard: drill and practice in the classroom

The mathematics teachers we observed were respected and experienced teachers in their schools, people who were deeply committed to their work. While most of them believed that varying teaching methodologies, and having practice at the subject, improved learning, learning itself was most often equated with the memorisation of formulae and procedures. It was not equated with thinking creatively, being able to provide reasons for solutions, or understanding how mathematics is used in the real world. The views of our case-study teachers were found to be broadly in line with those of mathematics teachers in the national TIMSS research (Beaton et al., 1996).

Teachers did not only hold a formal approach to the subject in theory, they also implemented a formal approach in class; their views of teaching influenced their pedagogical practices. We found a high degree of consistency between teacher reports of their pedagogical style and their actual pedagogical styles (Clark and Peterson, 1986; Shavelson and Stern, 1981; She 2000). Teachers reported that much of their time in mathematics lessons involved demonstration of procedures and monitoring of students' progress and the video analysis bore this out. Overall, the data from the teachers interviews confirmed that the didactic approach to teaching mathematics was the norm for the ten teachers in this study, both in theory and in practice.

All twenty mathematics lessons that we videotaped were taught in a traditional manner. While a very small amount of time was devoted to outlining lesson aims and homework in class, most time was spent on exposition by the teacher, followed by a programme of drill and practice. Overall teacher-initiated interaction comprised 96 per cent of all public interactions in the classes, and within this context a procedural rather than a conceptual and/or problem-solving approach to the subject prevailed. Little time or attention was devoted to the problem-solving nature of mathematics, to the practical application of mathematics in the physical world, or to alternative methods of solving mathematical problems, other than those prescribed by the text or the teacher. Teachers were far more likely to use lower order than higher order questioning, and to use drill and repetition rather than discussion-type questions, to teach mathematical concepts. The work programme of the class therefore was strongly teacher-determined, with a resultant lack of student participation in the organisation of their own learning. Learning for the examination was the central task. Mathematics was presented as a subject that was characterised by systems of strong classification and strong framing (Bernstein, 1977) That is to say, mathematics was generally presented as a fixed body of knowledge with a definitive content (framing), separate from other subjects (classification).

While there is evidence both from other recent research on Irish classrooms (Lynch and Lodge, 2002) and from our own study of English classes, that teaching in Irish second-level schools is strongly didactic, the evidence from this study is that mathematics classes are especially didactic. This finding confirms the findings from international studies regarding the strong adherence to traditional methods of teaching mathematics up to recent times (Nickson, 1992). While some countries have encouraged a more constructivist approach towards the teaching of mathematics, this is by no means a uniform trend even in countries like the United States where there has been much discussion of change (Romberg, 2001).

We found many similarities between the teaching of English and the teaching of mathematics, not least of which was the fact that classroom work was generally teacher led and teacher controlled in both subjects: 92 per cent of public interactions in class were teacher led in English compared with 96 per cent in mathematics (Chapter 8); however, we also identified several differences.

One of the most visible differences between the subjects was the manner in which the subject matter was presented to students. While mathematics was taught as a fixed body of knowledge English was not (Burton, 1994a). The pedagogical styles employed by the English teachers fostered investigation and discussion of alternative interpretations most of the time. They displayed a willingness to take different ideas and opinions on board in interpreting the text. In contrast, mathematics was not taught in an exploratory mode; it was generally presented as a given or received set of procedures to be learned, not as a problem-solving experience or as a subject to be constructed by the learner.

English was also characterised by greater relativity and openness to interpretation; an exploratory, interpretative rather than a positivist paradigm seemed to prevail. Whether these differences are a by-product of deep epistemological differences between the subjects, or merely differences in pedagogical styles that have developed in the cultures of teaching, is a matter of debate (Thomas, 1990; Burton, 1994a; White 1996). Whatever their origins, however, they led to very visible differences in the ethos of mathematics and English classrooms.

English classes also differed from mathematics in the way that learning occurred through conversation. Dialogue was a medium of learning in English in a way that it was not in mathematics. In addition, English teachers made connections between what had been learned in the past and what is currently being taught. They explained relationships between topics and provided the students with reasons as to why they were covering particular material in a lesson, or why they were being told to complete a certain exercise. There were also many incidences in which connections were being made between the subject of the text, real life situations and moral dilemmas, thereby indicating to students that English was a lens through which one could arrive at understanding of events in every day life. In contrast to this, mathematics was presented in a more formal way with much emphasis being placed on preparation for the examination. There was no such reference in the sample of English classes.

Fear and anxiety

'You can feel a bit weird asking a question.'
(a quote from an interview with a girl about her learning experiences in her mathematics classes)

There is a growing literature in mathematics education on the role of emotions and affective considerations in the learning of mathematics (Hazin et al., 2001; McLeod, 1992). While there are important differences within this literature between research on attitudes, values, beliefs and emotional responses generally, (with much research being done on attitudes and less on emotional responses) what is clear from the work is that mathematics is a subject that evoked strong feelings in people who have studied it. While those who have been successful in finding solutions or in making conjectures have experienced mathematics with pleasure and joy, one major study found that the prevailing emotional reaction of adults generally to mathematical tasks was that of panic (Buxton, 1981, cited in McLeod, 1992). Being asked to complete mathematical tasks evoked feelings of anxiety, fear and embarrassment as well as panic. Work by Boylan and Lawton (2000) and Boylan, Lawton and Povey (2001) suggests that feelings of anxiety, vulnerability and insecurity are still prevalent among second-level mathematics students.

Our own findings from interviews with students about their experience of their mathematics classrooms, and our analysis of video observations of these same classes, lend strong support to the contention that mathematics is a subject that evokes feelings of vulnerability among students. Students spoke about finding it 'unnerving' when questioned in class, feeling that 'everyone is watching you' when you are asked to do a problem on the board. They spoke about hoping 'you got it right' and feeling 'Oh no!' if you got it wrong.

Mathematics classrooms were remarkably uniform in terms of the prevailing discourse. There were regular references to 'the exam', with the subject matter being defined in binary codes as either 'difficult' or 'easy', 'hard' or 'simple'. Answers were classified also along polarised lines as either 'right' or 'wrong'. The subject of mathematics was one therefore in which there was a clear judgement of the student's work, a judgement that was often made in public. This implicitly, and at times explicitly, judgmental atmosphere created anxieties and tensions for students in relation to the subject of mathematics itself.

The importance of student feelings about mathematics was evident from the comments they made about their teachers. Teachers tended to be negatively or positively evaluated to a considerable degree in terms of how they managed students' feelings of exposure and vulnerability in mathematics classes. Teachers whom students claimed made them feel 'fearful' or anxious in class, or who 'gave out' to them for 'getting things wrong' when solving mathematical problems, were especially negatively evaluated.

Not only did students define their mathematics teachers negatively or positively to a noticeable degree in terms of the extent to which they made them feel vulnerable in class, they also expressed strong views generally about the fear they had about asking questions in mathematics classes. Students spoke of their fear of being exposed (and publicly criticised by their teacher, and silently mocked by their peers). Our conversations with them revealed the sense of pressure (especially in top sets or bands) that one was expected to 'get it right'. Other students said they were 'afraid of being put on the spot if they asked a question'. Even in classes where the students were positive about the teacher and the classroom experience as a whole, fear and anxiety were prevalent. In such classes, students spoke about being 'embarrassed to ask' 'if everyone else understands'. Even though students were encouraged to ask questions in these classes, as one group of girls put it '… you can feel a bit weird asking'. Students took their cues from other students, and were fearful of being the only one who needed to ask. One top set student said she waited to the end of the class to ask in the hope that the teacher might explain the problem again. If the teacher did not, then she would ask the girl beside her 'Do you understand that?' and if she says 'Yes', then I wouldn't ask'. Not all classes were viewed positively and in those that were not the sense of fear and anxiety was heightened by the fear of teacher criticism (as opposed to peer ridicule). There were numerous references to the fact that students did not like to ask questions in class, because the teacher might 'give out to you if you get it wrong'.

The fear of asking and 'being wrong' was especially strong in the top sets or streams. The fear that students felt in these classes was that one would be seen as 'stupid' in a class where others were 'just amazing'. In these classes also the pace of the class was regarded as being 'too fast'. Students said the teachers 'explained things too quickly', that there was 'a lot of pressure to do well'. They claimed the class ' is more competitive because you feel like if you don't know it you shouldn't be there'. One girl explained how the teacher questioned her persistently when she got something wrong until 'I was nearly reduced to tears about it in the end. And I rarely ask questions since'.

In contrast to mathematics classes, English classes were characterised by the absence of evaluative language, in particular terms such as 'wrong' or 'incorrect'. Neither was the material coded in advance for students in terms of its intellectual demands: no English teacher referred to material as 'hard', 'difficult' or 'easy'. The binary codes of 'right and wrong', 'hard and easy' seemed to be an integral part of the mathematics teachers' framework for presenting their subject, while English teachers did not utilise such binary and evaluative codes.

Does the teacher make the subject?

While there was a general tendency for girls, top stream classes, and middle class students to hold the most positive views of mathematics overall, the profile of the classes with the most positive perspectives on mathematics shows that teacher practices also impact on attitudes to the subject (Chapter 10, Table 10.6).[2]

Thus, while the most 'positive' class was a top stream and the highest-performing group in the TIMSS-related test, the most 'negative' class was also a top stream and was ranked second highest in the TIMSS-related test. In addition, while two of the 'positive' classes were in the top-stream in their year group, this was also the case for two of the most 'negative' classes.

The focus group discussions highlighted the importance of the style of individual mathematics teachers in determining attitudes to, and experiences of, the subject. Students' views of mathematics generally were very much mediated by the character and style of the individual teacher. All students spoke about mathematics in terms of their *teacher* and rarely mentioned other issues like the curriculum, the examination system or resources for the subject. Three types of teachers were identified: those who were perceived as 'good' and supportive of students in their work; those who were experienced negatively and were variously defined as being too critical of students' work, pressurising, or 'going too fast' and those who were experienced more neutrally as falling between the two extremes. This finding concurs with international research suggesting that students' views of the subject are strongly influenced by their classroom experience of learning it (Dick and Rallis, 1991; Johnston, 1994; Ma, 1997).

There were three teacher practices that seemed to contribute to negative views on mathematics: when teachers taught at a very fast pace, when they were critical of students when they made errors or sought help, or when they pressurised students to achieve without giving positive support. Students' accounts of mathematics classes were also more negative when the teacher lacked good humour, or rarely praised or encouraged students in class. Students who were positive about their experience of learning mathematics described their teacher as a 'good' teacher with a strong knowledge of the subject, capable of explaining the material and interacting with them in a humorous, supportive and non-judgmental way. Even in these 'ideal' circumstances, however, students were often reluctant to look for help from the teacher, seeing family or friends as a less threatening source of help. A fear of being seen to be 'wrong' was an overriding concern of students in all types of mathematics classes, a finding that concurs with those of Boylan and Lawton (2000), Boylan, Lawton and Povey (2001) and Picker and Berry (2001).

The extent to which students identified the subject with the teacher was especially evident in Errigal (CS Fr) where all the students interviewed (both girls and boys) had a positive view of the teacher. One student even said that she would rather stay with Ms Ennis and do Ordinary level mathematics than move to another teacher (even though she could move to a Higher level mathematics class if she wished). In this school, parents and students put in special requests to have Ms Ennis as their mathematics teacher. As one student put it: ‘ A lot of students come begging to her door to be taken into her class’. Ms Ennis had all the attributes of the good mathematics teacher from the students’ perspective: not only did she know her subject well, she was willing and able to explain the subject matter to the students; in addition she was non-judgmental, and did not make students ‘feel bad’ if they did not understand. She was respectful of the students, explaining material clearly, and was conscious of their vulnerability in class. The two other teachers (Mr Butler and Ms Brennan) who were defined as ‘good teachers’ by the students were also praised for their ability to explain topics clearly, with students in Mr Butler’s class in Blackstairs (VCC Fr D) pointing out that he was especially helpful as he ‘brings you out of yourself’, showed students different ways of doing problems, and ‘takes things [examples] out of his head’.

Good teachers, were not only those who were good communicators of mathematical knowledge, patient, good humoured, not sarcastic and fair, they were also people whom students were not afraid of. In defining her teacher as really good, one student pointed out that the reason for this was because ‘she doesn’t make you feel bad just because you made a mistake’, while one of the boys in the same class said ‘she wouldn’t make fun of you [if you got something wrong]. She’s nice like that – fair like’.

‘If they don’t have that innate mathematical ability… they are not going to improve’

(a quote from Mr Butler, one of the case study teachers)

All of the teachers in the case study, and more than nine in ten of the mathematics teachers surveyed nationally for the TIMSS, held strongly essentialist views about mathematical abilities: they believed that some students have a natural talent for the subject while others did not (Chapter 9, Figure 9.1). This finding concurs with previous findings by Fontes and Kellaghan (1983) regarding the strongly essentialist view of the Irish public generally and teachers in particular regarding the nature of human intelligence. What is surprising perhaps is that little appears to have changed in this respect in twenty years, at least with mathematics teachers. Implicitly, if not explicitly, a student’s attainment in mathematics appears to be taken as a surrogate measure of human intelligence. This occurs in spite of the vast international research indicating that mathematical intelligence is but one of a multiplicity of intelligences, and that all intelligences are strongly developmental in character (Devlin et al., 1997; Gardner, 1985; 1999).

The views that teachers held about mathematical ability were openly expressed at our interviews with them after their classes were videotaped. The most commonly used adjective to describe students who were not successful at mathematics was to refer to them as 'weak'. All ten mathematics teachers believed that mathematical talent was an innate gift that could not really be improved on if the student 'did not have it' or were very 'weak'. Even a teacher like Ms Ennis, who was very highly regarded by students, believed that there were certain students who were too weak to improve beyond a certain level. In the context of stressing the importance of building up students' confidence in mathematics and encouraging them to succeed, she observed that she 'couldn't bring [up] someone who is very weak'. 'I could not bring them up to honours standard – ability of course comes into it'. The two other very positively regarded teachers in the study (Ms Brennan and Mr Butler) as well as those who were more neutrally or negatively regarded, held similar views. Mr Butler pointed out that it was clear to him that 'in first year, some of them just won't have it with maths – they're not going to change … If they don't have that something, that innate ability, they just won't acquire it, it just won't happen'. Other teachers classified students as 'very bright', 'quite intelligent' or 'weak' in their discussions of their teaching.

Teachers' perceptions of how mathematical capabilities were acquired and developed impacted on how they interpreted the progress, or lack of it, of their students. Teachers generally attributed students' improvements in mathematics to having an innate ability, and being encouraged and supported by the teacher. On the other hand, teachers did not hold themselves responsible for any observed deterioration in students' mathematical performance. Here students' own attitudes, behaviour or lack of ability were deemed to be the main causal factors. Students that teachers defined as 'weak' were largely seen to have limited opportunities for advancement, although some of the teachers believed that it was possible to give such students more confidence and encouragement in mathematics.

The essentialist view of mathematical ability was not confined to teachers. Parents from all types of social backgrounds attached considerable importance to children's 'innate ability' for successful learning in mathematics (Chapter 11). However, those parents who were most educated and who had detailed knowledge of how schooling worked as a selection mechanism for work and education (the Insiders), attributed more importance to the quality of schooling than others. They were also the parents who regulated their children's schooling by intervening with teachers and, if necessary, moving children between schools.

Only the students themselves rejected the essentialist view of mathematical skill and ability. Unlike teachers especially, but also many parents, they attributed success in mathematics to good teaching and systematic study (Chapter 11). What appears to be happening in education therefore is that students who enter second-level schools with low rates of attainment in mathematics, or who do not achieve in their first years in second-level school, come to be defined as 'weak students' (not weak-at-mathematics) by teachers in particular, but also even by parents. What is, in effect, a quality of attainment in a given field comes to be defined as a defining attribute of the person. The irony is that future achievements are explained in terms of this dubiously defined attribute. What is called mathematical 'ability' is merely mathematical attainment at a given time on a given (pen and paper) test for a given student. Using it to explain attainment at a later date is to explain mathematical attainment in terms of itself (Secada, 1992).

Using tests of attainment to define students' entire educational profile is a seriously problematic educational practice (Gardner, 1985, 1999). Yet it is by no means confined to mathematics. The labelling of students as 'weak' (especially) or 'bright' seems to be endemic in schooling in Ireland, with its attendant dangers of creating a self-fulfilling prophecy for students who are negatively defined (the so-called 'weak ones'). Given the strong interface between working class status and lower attainment generally, the problem is especially acute for working class students. Lower attainments, which are generally the by-product of major differences in resources and opportunities across classes and groups, comes to be defined as a personal attribute of the individual, something that cannot be changed. What is in effect a social product becomes a psychological construct (Secada, 1992). This is an educational practice that needs to be seriously deconstructed and challenged if schools are to be part of the solution rather than reproducers of the problem of inequality in education (Lynch and Lodge, 2002).

The gender code: gender balance and gender awareness

There were ten coeducational classes in the study and in four of these boys received significantly more teacher attention than girls; there was only one class in which girls received significantly more teacher attention. While the remaining five classes were more gender balanced, in all but one of them teachers interacted more often with boys than with girls (Table 6.1, Chapter 6).

Not only were girls less likely to get attention in coeducational classes, girls were, on average, less likely to ask questions and to be asked a question by the teacher than boys. Although there were few higher order questions asked in any of the classes, girls were slightly less likely to be asked these than boys in coeducational classes (although the girls in coeducational classes were asked more of these type of questions than girls in single sex schools). As almost all public interaction is work-related, the findings indicate that boys are effectively more involved in the business of the mathematics lesson than girls in coeducational schools. The only area in which girls in coeducational classes got more attention than boys was in terms of praise, although neither girls nor boys received much praise overall.

Aggregate scores for all classes conceal important variations *within* individual classes however. They also blind us to differences between the learning climates in single sex boys' and girls' classes. In all the coeducational classes in which boys dominated, it was a small minority of boys who were involved. These boys dominated the interaction compared with other boys as well as girls, a finding that concurs with that of Lynch and Lodge (2002) and Barnes (2000). The tendency for a small number of students to dominate classroom interaction occurred also in boys' single sex classes, but not in girls' classes.

Interestingly, the gender differences in interaction patterns across single sex classes were more noticeable than those within coeducational classes. In all, 57 per cent of boys in single sex classes were not asked any questions while this happened to only 9 per cent of girls in single sex classes. In coeducational classes 27 per cent of boys and 31 per cent of girls were not asked any questions in class. What is clear therefore is that the girls' mathematics classes were more inclusive in terms of teacher-student engagement than coeducational classes, and particularly more inclusive than boys' classes. Within coeducational classes however, more boys were more actively involved with the teacher in working on mathematical problems within the class than girls.

When the factors associated with different gender patterns of interaction were examined, the most important factor appeared to be teacher awareness of the need for gender balance. The classes that were most gender balanced were those in which the teachers were gender aware. Of the five teachers of coeducational classes, it was the three female teachers who displayed most awareness, with one teacher operating a systematic policy of gender balance in her class.

The analysis of the video material from classes that were most male-dominated suggested that having a disproportionately large number of boys in the class, having a teacher who focused on boys and their interests, and having a teacher who had low gender awareness, all contributed to lack of gender balance.

The boys who dominated exercised hegemonic learning styles (by shouting out answers, calling for attention, moving and shuffling at their desks, or interrupting other students and the teacher). They dominated the verbal, and sometimes the physical, space of the groups to which they belonged, although the styles they adopted varied with the culture of the school and indeed the stream or track they were in. Overall they had interactional styles that were competitive in attention-seeking terms, and exhibited traits of dominance commonly associated with hegemonic forms of masculinity (Mac An Ghaill, 1994; Connell, 1995).[3] Teachers seemed to co-operate with dominating students when their dominance involved work interactions; they were forced to engage with it when it involved disruptive behaviour.

The findings confirming the dominance of boys in coeducational classes is in accord with the general findings in other studies internationally (Drudy and Uí Catháin 1998; Howe 1997; Lee 1993; Sadker and Sadker 1985; Warrington et al., 2000). However, the findings also suggest that aggregate gender scores for classroom interaction conceal important differences between and within classes. Male dominance in classes is accounted for often by a minority of boys (and this happens to a greater degree in single sex boys' classes than in coeducational classes). Such boys control the learning environment not only for girls but also for other quieter boys in the class (Barnes, 2000; Lodge, 1998; Lynch and Lodge, 2002).

Although Howe (1997) has drawn attention to the fact that there is a lack of evidence linking male dominance in class with superior examination performance, nonetheless our findings do raise questions about the overall long term effects for girls and certain quieter boys of being subordinate in their classroom experiences. There is evidence that public disengagement may reinforce negative attitudes to traditionally 'non-female' subjects among girls (such as mathematics) even if it does not directly influence examination performance (Jovanovic and King 1998). The regular day-to-day experience of lacking control and influence in class is most certainly a form of socialisation. Certain young women and subordinate males are practising being relatively silent in the presence of other young men in coeducational classrooms. Given that our interviews with students about their experience of mathematics' classes showed that girls were more afraid of asking questions and seeking explanations than boys, it would seem that the competitive culture of mathematics classes (especially true in top streams) may be alienating girls from identifying with the subject (Chapter 10). However unintended, mathematics classes are often experienced by students, and particularly by girls, as threatening environments. They are places in which errors can result in naming and shaming in front of your peers, something all students want to avoid.

Most research in classrooms focuses on the actively engaged or the actively deviant. There is a real danger however that the majority of students, be these girls or boys, are ignored in the process. Because the quietly disengaged are not disruptive in class, this does not mean that their silence is unproblematic (Nardi and Steward, 2001). While students may be quietly engaged, there is a very real danger that their silence is indicative of a detachment from the subject and the learning process. Their non-participation may be a rational choice to opt out of the subject, as often as it is indicative of quiet contentment, or a symptom of pathology (Dorn, 1996).

On the more positive side, the data do indicate however, that not all coeducational classes are male-dominated. Those classes in which teachers were strongly gender aware, and those in which there were a relatively equal number of girls and boys, were the most egalitarian in terms of interaction. Such gender-balanced learning environments have been found to promote improved attitudes to learning among girls in non-traditional subject areas (Jovanovic and King, 1998).

Another positive finding from the study relates to teacher attitudes to gender. While earlier studies of teacher attitudes to gender differences in mathematics found that teachers held quite stereotypical views of female and male capabilities and approaches (Fennema et al., 1990), our interviews suggest a more complex picture of gender perceptions among teachers. Teachers were quite hesitant and ambivalent in their interpretation of gender relations, with only one of the ten holding clear stereotypical views. Teachers were almost equally divided between those who thought that there were no gender differences in success rates in learning mathematics, those who did not know and those who said there were differences. Girls and boys were seen as having different approaches to the learning of the subject, not as being more or less capable at the subject. The findings concur with related research by Leder and Forgasz (2000) and Francis (2000), both of whom found evidence of a decline in gender stereotyped expectations among students, the former in relation to mathematics, and the latter in relation to students' subject preferences. Our findings also lend support to Arnot's (2002) and Connell's (1997) claims that concepts of femininity and masculinity are becoming increasingly fractured and diverse in contemporary society.

Class actions: the importance of grouping procedures and parental interventions

Traditionally much research on mathematics education has been 'unidimensional in scope'. Studies examined 'issues of social class, race, language background or gender in isolation from each other' (Secada, 1992, p. 635). In addition, social categories of student diversity have often been treated as unquestioned givens, being often transmuted into other issues in the research analysis. The lack of interest in student diversity in mainstream mathematics education was, according to (Secada, ibid, p. 654), 'both unconscionable and untenable'.

The diversity deficit has begun to be addressed in recent years as scholars recognise increasingly the interface between the psychological, the cultural, the political and the social in determining learning outcomes. It is increasingly accepted that gender is but one 'code' within schools and classrooms (Arnot, 2002); gender interacts with, and is influenced by other differences. The social turn in mathematics education has generated a growing recognition that social origins and atrributes play a crucial role in the learning process (Lerman, 2000; Wenger, 1998). It is accepted increasingly that learners are not simply of a particular gender, race or social class; they simultaneously embody and recreate the structurally situated particulars of their own social class, gender, race, ethnicity and sexuality. Therefore, binary oppositional categorisations based on gender (or race or class) alone are not adequate for analysing classrooms (Gordon 1996, p. 36).

What we undertook to do therefore was to examine the ways in which gender experiences interfaced with social class experiences. The findings from our own analysis of Junior Certificate data, and the results of a range of other studies, had indicated that learning experiences are mediated by social class in particular[4], and also by the track (stream, set or band) to which one is allocated (Hannan and Boyle, 1987; Lynch and Lodge, 2002; Oakes, 1985; Sorensen and Hallinan, 1986). As international research increasingly emphasised the important role parents played in determining students' relationships with school (Gewirtz et al., 1995; Lareau, 1989; Reay, 1996; Wells and Oakes, 1996), we also focused attention on how different types of parents related to schools and to the teaching of mathematics.

In common with a number of international studies, both nationally and internationally, we found that top tracks experience a more intense, work-focused and competitive learning environment than lower tracks (Boaler, 1997c; Burgess, 1983; Gamoran, 1986; Oakes, 1985; Lynch and Lodge, 2002). There were important qualitative differences in the *type* and *quality* of pedagogical practices deployed by teachers in different tracks. The most striking differences were found between the bottom and top streams. In the bottom stream, the teacher's pedagogical approach was characterised by slow pace, constant repetition and an emphasis on the practising of very basic, procedural skills (Chapter 7). The teacher's approach appeared to reflect the generally low expectations held of the bottom stream. The pedagogical approach of the teachers of the top streams was characterised by a fast pace and an air of urgency. The teachers had higher expectations of the higher streams or tracks.

A dialectical relationship appeared to develop between the teachers' pedagogical styles and the students' learning styles across tracks: the dependent and unconfident attitudes of the low track students to mathematics, combined with low proficiency of basic skills in the subject, seemed to evoke a response from teachers that reinforced dependency. The teachers focused on developing basic procedural skills, moving slowly and systematically through the material with very low-level questioning and answering. In high tracks, the opposite dynamic was in operation.

The analysis of mixed 'ability' classes gave a very clear indication of how social class and stream can interface with each other. While mixed classes did occupy an interim position between top and bottom tracks generally, in terms of learning and teaching climate, their social class composition seemed to impact on whether the ethos leans towards that found in top or bottom streams. The learning climate in the mixed 'ability' class in an upper middle class school was more similar to that in a top stream, while the mixed class in a more lower middle class and working class school was similar to that in lower streams or bands in other schools. The findings here concur with other research which suggests that grouping by so-called 'ability' is an important part of the process of social class reproduction (Lynch and Lodge, 2002).

The cultural deficit interpretation of class difference

The analysis of teacher expectations and perspectives on students indicated that these were influenced by the students' social class background (Sorenson and Hallinan, 1986; Taylor, 1993; Wang and Haertal, 1995; Hallam and Toutounji, 1996). In Suir (a designated disadvantaged girls' school) the teacher believed that the students' poor performance in school was directly related to their 'disadvantaged' family background rather than an outcome of the grouping system or teaching they had received. However, she did say that many of the bottom stream '*lacked the basic skills*' of mathematics when they came to second-level education. By contrast, in Barrow (a fee-paying girls' school) and Lee (a fee-paying boys' school) the teachers believed that the students' middle class backgrounds had a positive impact on their learning. Moreover, the teachers of these classes indicated that they had high educational expectations for their students. This contrasted with the relatively low expectations of the teacher in schools such as Liffey (a boys' disadvantaged school) although the class observed in Liffey was a top stream within that school.

While teachers held quite varied views on gender roles and relationships, they were more unanimous in their views on social class. Overall, teachers tended to adopt a cultural deficit interpretation of the lower rates of attainment of working class students; low achievement among working class students was primarily interpreted in terms of the perceived 'inadequacies' of their cultural background. It was not regarded as a by-product of prior teaching in particular, although teachers did also recognise that the greater resources (educational and material) available to upper middle class students were crucial to their educational success. Six of the ten teachers claimed that students from 'poor' backgrounds were disadvantaged in learning mathematics by their parents' lack of knowledge of, and especially interest in, education. Only one of the ten teachers claimed that schooling procedures (labelling students from particular backgrounds and placing them in low streams/tracks) contributed to their lower attainment. Our findings here concur with other Irish research on teacher attitudes to students from working class backgrounds (Lynch and O'Riordan, 1998).

Parent Power

Our data corroborates the findings from a number of other studies regarding the key role that parents can play in the education process. Their capacity, or lack of it, to choose different schools or to intervene on educational matters on behalf of their children, can and does radically alter the nature of their children's education (Lareau, 1989; Useem, 1992; Wells and Serna, 1996; West et al, 1998).

We found that parents' own educational experience, including their experience of mathematics, influenced their relationship with the school and the subject. Those with positive experiences of mathematics, and especially of schooling generally, were the most likely to be proactive on behalf of their children. From the interviews with parents, it was clear that upper middle class parents in particular were those who had the most informed and positive views on education generally. They also had the cultural, social and financial capital to act in their children's interests (Bourdieu and Passerson, 1977; Gewirtz et al, 1995, Reay and Ball, 1998). They were part of resourced social networks that enabled them to give considerable support to their children. The Insider parents were also integrated into school affairs, engaging in different forms of intervention in their children's schooling as the need arose.

In contrast, the Outsiders had much lower levels of education themselves and were mostly from working class backgrounds. They had more negative attitudes to schooling and mathematics based on their own experiences. They lacked the resources, skills and knowledge to intervene in their children's education to the same degree as the Insiders. The Outsiders did not have complete information when making choices with their children's schooling; they did not understand fully the implications of taking Ordinary or Foundation-level examinations for both the educational and occupational future of their children. The Insider parents, however, were keenly aware of the limitations of taking subjects at lower levels and made it clear that they resisted such placements. Some said they were willing and able to take their children out of particular schools if they were not taking subjects at Higher levels.

The third group of parents, the Intermediaries, occupied an interim position between the other two groups, although they were more similar to the Insiders in social class terms. What differentiated them most from the Insiders however, was not so much their lack of knowledge of the education system, as their lack of control over their children's schooling. Unlike the Outsiders, they knew how schooling worked and how it selected children out occupationally for the future. However, they seemed to lack the resources to act on this knowledge. They worried about their children's schooling without controlling it.

What seems remarkable from the interviews with teachers and parents is the lack of obligation on schools (and the lack of resources available to them) to make up the deficit in parents' knowledge of schooling. There is no procedure or mechanism for informing parents about how the school system works from the inside out. In particular, parents are not informed in any systematic way about the grouping of children in school, or indeed about the implications of grouping or taking subjects at different levels.

There is no doubt but that the different patterns of take-up for different levels of mathematics across school types (reported in Chapter 2) is related to the information differential and the resource differentials between parents across social classes and groups. The fact that the take-up of Higher mathematics is highest in fee-paying schools and lowest in vocational schools and community colleges (almost half of which are designated disadvantaged) indicates strongly that the most disadvantaged schools may be reinforcing class inequalities by the manner in which they provide subject options. There is no doubt that certain students are entering second level educationally disadvantaged in mathematics, as was observed by a number of the teachers we interviewed. However, this begs the question as to why this is the case and why the problems have not been addressed at primary level. It also forces us to ask why it is that second-level schools are not given the resources and supports to make up the deficit rather than being required to accept it as an annual given, simply because the students come from a particular social class background.

One of the problems in Irish schools seems to be that schools' accountability in terms of how they group students, or the level at which subjects are offered to different classes of students within school, is largely parent dependent. If parents do not demand or ask for information they are not offered it. If parents do not know what questions to ask, no one tells them what they need to know to make an informed judgement for their children's future. The injustice of ignorance is a major issue not being addressed in education.

Concluding remarks

While mathematics is, arguably, taught in a more didactical style than other subjects, the epistemological and pedagogical frames utilised in the teaching of mathematics is but a variation on a wider theme (see Chapter 4). A system of strong framing (strong rules governing what is to be known and how) and strong classification (strong boundaries between subjects) (Bernstein, 1977) characterises most subject teaching in schools. School subjects, with some minor exceptions, have clearly defined boundaries and content; they are not presented in an integrated manner. In addition, the syllabus is presented largely as a set of certainties or skills 'to be grasped' by students for 'the exam'. While there are variations in epistemological assumptions and pedagogical practices, and in the discourses employed across subjects (as can be seen in our analysis of English classes in Chapter 8), there are also several remarkable similarities between them (Lynch and Lodge, 2002).

To interpret the traditional approach to the teaching of mathematics as a matter of individual teacher choice and responsibility, therefore, would be to simplify a complex problem in teaching and learning. Mass public education has a long history in western European societies; it is a history that demonstrates a strong allegiance to 'drill and practice' for all subject teaching, not just for the teaching of mathematics (Bowles and Gintis, 1976; Coolahan, 1981; Foucault, 1977). Moreover, recent research on Irish schools reveals that they are deeply hierarchical in their organisation and practice, and this is not confined to any particular subject (Lynch and Lodge, 2002). While it is true that teachers are relatively autonomous in their own classrooms, in terms of the pedagogical approaches they employ, they are also subject to a range of internal as well as external controls, not least the control of public examinations. They experience their own role as both powerful and powerless and this, in turn, influences their capacity and motivation to be innovative or experimental (Davies, 1996).

If we are to achieve change in teaching practice, the focus cannot simply be on changing teaching practice itself, important though this may be. As Thompson (1992) has observed, changing dispositions and even the architecture of schools does not change the relations of power and domination in mathematics classrooms. To understand how education works and how change can be realised, one needs to marry psychological models of teacher and student beliefs with a structural analysis of how beliefs and attitudes are patterned and reproduced over time. 'As researchers, it requires us to go beyond the data of observable practices and into the realms of those patterns and generative principles of which the teachers themselves may not even be aware' (Gates, 2001, pp. 22-23). For policy makers it requires a shift in emphasis from the individual to the school organisation, and from the school itself to the wider socio-cultural and socio-political structures of which it is a part. It is not possible to change classroom practices by simply focusing on student or teacher attitudes and practices, important as these may be. Attitudes and values, and teaching practices, exist in the wider field of mathematics education and of education generally. They are situated and constrained by the wider social context of external examinations, parental expectations, the structures of paid and unpaid labour markets, the hierarchical ordering of educational relations, as well as the traditions and identities of particular schools. To understand and to change traditional approaches to the teaching of mathematics, therefore, we need to be mindful of the wider educational and socio-political contexts within which teaching takes place.

Notes

[1] This has already been well established to be true for working class boys (see Willis, 1977)

[2] Although students in the three bottom streams (Suir, SSG Fr D, Nephin, VCC Fr, Mourne, VCC Fr D) did not have positive attitudes to mathematics or positive self images, expectations or learning experiences, students in one of these, Nephin, had more positive attitudes to mathematics than the boys in the mixed class in Lee (a fee-paying boys' school) where all of the boys were planning to do Higher level mathematics. Even their mathematics self image was only marginally lower than that of the boys in Lee. The students in Nephin (VCC Fr) (a bottom stream) also had more positive attitudes and self images than the top stream in Liffey (SSB Fr D). The classes in which low levels of negative interactions with teachers were reported (Barrow SSG F) and Errigal (CS Fr)) were also those where attitudes and self image were most positive.

[3] Connell (1995) suggests that domination of women and subordinate men is one of the defining features of hegemonic masculinity.

[4] Race and ethnicity are of growing significance in determining one's educational

experience in Ireland, especially since 1997 (when this study was planned) (Fanning et al., 2001). In addition, there is a growing public recognition that differences arising from sexuality, religion and disability can and do result in exclusions within schooling generally (Lynch and Lodge, 2002). We did not focus on these differences in this study, however, not because we do not think they are important, but rather because our own study of Junior Certificate data, and previous Irish research, had indicated that social class and socio-economic origins had a major and prolonged impact on educational outcomes in Ireland (Clancy, 2001; Hannan et al., 1996). To explore the impact of disability, ethnicity or race on students' learning experience of mathematics in any depth would require a separate and more focused study.