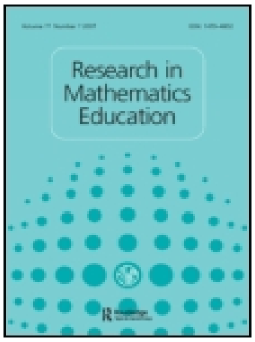

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"I would rather die": reasons given by 16-year-olds for not continuing their study of mathematics

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Improving participation rates in specialist mathematics after the subject ceases to be compulsory at age 16 is part of government policy in England. This article provides independent and recent support for earlier findings concerning reasons for non-participation, based on free response and closed items in a questionnaire with a sample of over 1500 students in 17 schools, close to the moment of choice. The analysis supports findings that perceived difficulty and lack of confidence are important reasons for students not continuing with mathematics, and that perceived dislike and boredom, and lack of relevance, are also factors. There is a close relationship between reasons for non-participation and predicted grade, and a weaker relation to gender. An analysis of the effects of schools, demonstrates that enjoyment is the main factor differentiating schools with high and low participation indices. Building on discussion of these findings, ways of improving participation are briefly suggested.

Keywords: participation; attitudes; post-compulsory

Background and aims

Recent reports have stressed the serious shortage in the UK economy of people qualified in science, technology, engineering and mathematics (STEM), with the rising demand outstripping a declining supply (Roberts 2002). The Smith (2004) report in particular, stressed the national need for more young people to study mathematics for longer.

Meanwhile, entries for General Certificate of Education (GCE) Advanced (A-level) mathematics examinations at age 18, where mathematics is studied normally as one of only three or four specialist subjects, fell by 28% between 1982 and 2003. By the end of this period only 7% of the age group were studying A-level mathematics (Matthews and Pepper 2005). The UK government therefore set targets for an increase of 21% in the number of A-level passes in mathematics (Her Majesty's Treasury 2006).

Some of the decline followed the introduction of *Curriculum 2000,* which split the A-level course into modules at Advanced Supplementary (AS-level), usually taken at age 17, after which some students continue no further, and A2-level, usually taken at age 18. Despite an upturn in 2005–2007, and the fact that mathematics is now the second most popular GCE subject (Matthews and Pepper 2007), the number of mathematics A-level students has not yet climbed back up to the 2001 figure.

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The long-term trend of falling participation also affects other developed countries (Holton et al. 2001), although most countries do expect all students to continue with some study of mathematics until they leave school.

The authors of this paper had access to an existing large-scale data set gathered as part of a project funded by the Qualifications and Curriculum Authority (QCA) on alternative forms of General Certificate of Secondary Education (GCSE) examinations, taken by almost all students at age 16 (Stobart, Bibby and Goldstein 2005). In view of the policy interest, we decided to analyse the relevant part of the data to see whether it provided any useful insights into students' motives for discontinuing with mathematics at age 16.

There are a number of related studies which explore student participation in, and/or attitudes to, mathematics, both inside and outside England. Students' choice of subjects has been shown to be influenced significantly by their attitudes to the subjects and performance in them (Dick and Rallis 1991; Johnston 1994). Osborne et al. (1997), in a comprehensive research review of participation in STEM subjects, reported that the main reasons why students chose to discontinue their study of mathematics were that it is perceived to be 'hard', 'boring' and 'useless'. This is consistent with findings from more recent studies about attitudes (e.g., Nardi and Steward 2003; Kyriacou and Goulding 2006). Osborne et al. also highlighted the case of girls, whose participation was and continues to be significantly lower than that of boys, in spite of similar attainment at age 16. Several studies have specifically addressed reasons for the gender effect, most recently Mendick (2006). Finally, in parallel with our analysis, QCA was also carrying out a large-scale longitudinal research project on participation in A-level mathematics (Matthews and Pepper 2007).

Rather than summarising findings in these and other studies in detail at this point, we will integrate them with the reporting and discussion of our own results. We will report more briefly on our results where they support those of others, and at greater length where they add something new.

Methods

The data for the research was taken from a QCA study evaluating the 2005 pilot and trial of new two-tier GCSE maths examinations (Stobart, Bibby and Goldstein 2005). The broader study included a four page questionnaire given to students immediately after they had taken their GCSE examinations and before they had received the results. This research is based on answers given by the students to a small part of the questionnaire that was not analysed as part of the main study.

The sample consisted of 1997 students in the GCSE cohorts from 17 schools. Of these students, 1510 were predicted to get grades A*–C, and thus form the pool from which future AS-level students could be drawn.

The choice of schools was dictated by the three national bodies licensed to award GCSE qualifications which were involved in the QCA study. Each awarding body had been asked to find schools which were willing and able to participate in the study, and which were broadly representative of the spread of schools they served. The combined group includes a wide range of schools with respect to their geographical spread across England and Wales and their size range (106–410 pupils in the GCSE cohort). There was one single sex school (boys') and two faith schools. The boys' school is excluded from analysis of gender differences.

However, the sample of schools is not completely representative, as it is somewhat above average in terms of overall attainment. The percentage of pupils in the 14 English schools achieving five or more A*–C grades in GCSE examinations ranged between 30–85%, with a mean of 65%, compared to a national English average that year of 57%. This bias was also evident when the distribution of predicted grades in mathematics was compared with national GCSE results. Comparable data was not available for the three Welsh schools. Therefore, while the sample is large and varied, it is likely that the results of the survey are rather more positive than would be expected of the whole population of schools in England and Wales.

Predicted GCSE grades were used in the analysis below, and are important, as they would have been available to students while they were choosing AS-level subjects. (Clearly the awarded grades will have affected students' eventual choices, but we do not have this information; nor do we have any data on the closeness of awarded and predicted grades.) In addition to information about school, gender and predicted grade, the relevant questionnaire items available for analysis were:

Circle any words that fit you

Words that describe how I feel about maths (add other words if you would like):

Enjoy Like Hate Bored Frightened

Excited Anxious Worried Difficult Easy

_______ _______ _______ _______

Are you planning to stay on at school or college next year? Yes/No

If you are, what courses/subjects are you intending to study?

Did you or have you ever considered studying maths at AS or A2 level? Yes/No

Why/why not?

We undertook the analysis of these questions in the following stages:

1. We found the proportion of students who had ringed, or written in, each descriptive attitude word/ phrase. Where there seemed no clear distinction in meaning, words were grouped together (e.g., 'worried' and 'anxious').
2. Choices of subjects for AS-level were analysed only in terms of whether or not students included mathematics in the subjects they intended to study.
3. Proportions of students who had considered and not considered taking mathematics were found. The reasons given for their decision were coded iteratively, and finally grouped into what appeared to be the major distinct themes. The proportion providing each category of reason was calculated.
4. After the analysis of results for the full sample, there was a re-analysis by predicted grade and by gender for individual students, and also by school.

Findings and discussion

Results for individual students

There was a very clear relation between the predicted grade and the likelihood that students intended to continue with mathematics, or had considered doing so.

Table 1. Students who considered/intended continuing with mathematics, by grade.

Predicted Grade	A* (n = 115)	A (n = 282)	B (n = 435)	C (n = 621)
Considered continuing with mathematics	90%	76%	34%	13%
Intending to continue with mathematics	71%	59%	17%	4%

The data in Table 1 show that the proportions of predicted A* and A grade students who take mathematics is relatively high, but the differences of about 20% between those who considered and those who intended participating suggests that there is some potential for increasing the proportion of high attaining students who select mathematics as a specialist subject. However, the greatest potential for increase comes from those predicted at grades B and C, where there is a significant drop in both the percentage considering, and in the proportion of those who considered who expressed a firm intention to continue. To relate this data to the cohort, about 93% are entered for mathematics GCSE, and in 2005, of those entered, 4% received grade A*, 9% grade A, 18% grade B and 23% grade C.

Matthews and Pepper (2007) note that in terms of recruitment, mathematics A-level students have the highest mean GCSE score of all major subjects, and that in 2005/6, 78% of them had a grade A or A* in GCSE Mathematics, while only 19% had B and 3%, C. They relate the drop at grade B to both the policies of schools and colleges in accepting students (although they found that the majority do accept grade B), and in the perception of students that mathematics is only for a 'clever core' (Matthews and Pepper 2005) or an 'elite' (Nardi and Steward 2003).

Table 2 indicates categories of reasons given for not considering taking up mathematics by students at each grade. As noted earlier, this was a free response question; students' reasons were grouped iteratively into categories which were then labelled by us.

The results in Table 2 demonstrate that many of the categories of reasons given for not continuing with mathematics are also strongly grade-related. In the discussion which follows the categories are further grouped under headings of 'difficult', 'boring/ don't enjoy' and 'not useful/not needed', which also happen to correspond broadly to the descriptions 'hard', 'boring' and 'useless' used earlier by Osborne et al. (1997). Where possible, sub-categories of responses are identified; these are sometimes illustrated by quotes from student responses selected as being most able to typify that

Table 2. Student reasons for not continuing with mathematics, by predicted grade.

Predicted Grade	A* (n = 23)	A (n = 96)	B (n = 317)	C (n = 540)
Too difficult	22%	47%	62%	58%
Do not enjoy/ like it	17%	39%	39%	30%
Boring	13%	20%	13%	14%
Not needed for future degree/ career	35%	13%	10%	10%
Not useful in life	9%	6%	3%	2%
Prefer other courses	17%	3%	2%	3%

Note: these are percentages of those students who gave any reason; some gave more than one reason, so percentages may total to more than 100%.

sub-category. Sources of quotes are identified by gender, school number and predicted grade, respectively.

Maths is difficult

Or, as one student put it:

> Its just too damn hard (M-3-A)

From Table 2, we can see that at all predicted grades but A*, the most prevalent reason that students wrote for not continuing with mathematics was the perceived difficulty of the subject. Thus, rejection on grounds of difficulty is common, even amongst those predicted to do well enough to achieve a grade A, which would place them between the 4th and 12th percentile of the cohort (see also Matthews and Pepper (2005)).

The issue of 'difficulty' is problematic; at one extreme it can be used as a dismissive label for a complex set of experiences which might be too painful to think about. One potential analytic stance would be to ask: where do messages of 'difficulty' come from? Are they always a reflection of real or anticipated struggle or failure? Certainly our findings correspond to those of Matthews and Pepper (2005) and Kyriacou and Goulding (2006) in suggesting that many messages about difficulty in relation to *future* struggle come from outside: from the experiences of friends and family and from teachers. Amongst many students, perceptions had been informed by those who had already taken AS-level or were currently on the course, including older siblings:

> Everyone who I have spoken to who is on the course says it is way too hard and is not worth it (*M-6-B*)

> My sister found A2 maths very hard and her frustration with it persuaded me not to study it *(M-13-A)*

It is possible that these reports of 'difficulty' are seized upon with relief, and provide an external and therefore acceptable rationale for students not to continue.

Such external messages might also come either directly from teachers or indirectly from school or examination practices. To be told by teachers that a subject is too difficult for you has serious implications. We derive our identities in part from messages we receive about ourselves; in this way low expectations create 'low attainment' as much as they respond to it. It is therefore of concern that teachers often reportedly added to the perception of difficulty, indicating that they too consider mathematics to be a particularly difficult AS/A-level:

> I did consider doing maths at six form but was informed by one of the teachers there that if I did not get an A in my GCSE then there was no point taking it at A level (*M-6-B*)

> I have been told by teachers it is too difficult for me *(M-4-B)*

Teachers are clearly giving messages that to obtain a grade B at GCSE is not to do well, although this achievement would put students between the 12th and 29th percentile of the cohort. In problematic relation to the messages from teachers, come messages also from the structure of the curriculum, the examination system and the grouping practices schools adopt in response to these (see also Boaler 1997a, 1997b; Boaler and Wiliam 2001):

> I feel that because I only did intermediate level [easier papers which allow a top award only of grade B] at GCSE I would not be confident enough to continue at AS or A2 level (*F-6-B*).

This all helps to maintain students' low 'self-efficacy' in mathematics, which has been highlighted by many other researchers (e.g., Hannula 2002; Pietch et al. 2003; Matthews and Pepper 2005; Kyriacou and Goulding 2006).

Externally imposed structural boundaries, such as examination systems, curricula, and grouping practices, may encourage perceived cognitive boundaries. Some students appeared to believe that there were fixed 'boundaries' for each individual person in mathematics, beyond which learning becomes extremely difficult and frustrating, and several pointed towards this personal 'fixed boundary' effect within their reasons for not continuing with mathematics:

> [I] always feel as if there have been boundaries…not sure I am at the correct level to attempt AS (*M-6-B*)

> I struggle with some parts of maths, and so do not think I am good enough to do it at A level (*F-6-A*)

> I cannot do some of it at GCSE, so the thought of learning more seems very daunting to me *(M-3-B)*

This perceived fixed boundary, between what mathematics is possible for a student and what is not, is supported by what appear to be enigmatic results in the questionnaire, where just over 5% of all students circled both the words 'difficult' and 'easy'; one student explained the apparent ambivalence:

> …easy when I can do it, difficult when I cannot *(M-8-B)*

The notion that there are sudden break points in mathematics, where difficulties are encountered or failures occur, is reinforced at institutional level. For example, one such boundary is created by the move from GCSE to A-level, and the somewhat magical maturational and academic step this is believed to be:

> I have heard that it is a huge step up from GCSE *(M-4-A)*

Similarly, and as demonstrated by the students predicted a B above, tiered examinations and setted classes reinforce the idea and strength of the boundaries, and the identities constructed in relation to them: I am this kind of person, not that kind. Challenging these identities based on perceptions of boundaries, whether personal boundaries perceived by students in relation to aspects of mathematics or boundaries created by institutional and curricular hierarchies, would appear to be important.

Maths is boring, I don't enjoy it

Williams and Ivey (2001) suggest that students who disengage from mathematics attribute apparently permanent characteristics either to themselves ('I am not interested in maths'), or to the subject ('maths is boring'). This provides a rationale for discussing these two categories together.

Table 2 shows that, for students predicted to get grades A, B or C, the second and third most prevalent reasons for not continuing with Mathematics are lack of enjoyment and a belief that the subject is boring. Indeed, if these are combined, they provide the most frequent reason for students predicted grade A not to participate. Matthews and Pepper (2005) also note that the perception that mathematics is 'dull' is expressed by high-attaining as well as low attaining students.

In a study of Key Stage 3 (age 11–14) students, Nardi and Steward separate out distinct negative perceptions of mathematics into *tedious*, *isolated, rote learning*, *elitist,* and *de-personalised*, noting the lack of affective dimension as a perceived characteristic, e.g., in mathematics there are "no positive or negative emotions, you just have to do it. It's like a null period." (Nardi and Steward 2003, 361). These perceptions were attributed to the concentration on 'teaching to the test' and not enough emphasis on engaging and inspiring students. Teaching methods were also criticised in other participation studies (Quilter and Harper 1988; Landau 1994; Matthews and Pepper 2005), and, in the 14–19 age range, by the school inspectorate (Ofsted 2006).

We might also speculate that these negative perceptions have the potential to be intimately bound up with the complex ideas associated with 'difficulty'. Students may wish to distance themselves from emotional involvement in a subject in which they do not feel very successful; the lower levels of disaffection expressed by students predicted A* may support this hypothesis.

In the attitude words item on the questionnaire, *bored* was the word selected most frequently as a description for mathematics (37% of students). 'Bored' can suggest a lack of engagement and/or a feeling of dullness:

> Throughout school life, I have not been interested in maths. I may be reasonably good at it, but feel the lack of interest would not survive the subject (*M-4-A*)

However it may hint at other feelings. For example, some students were more explicit about the reasons for being bored, for example the lack of opportunity for creativity:

> I enjoy subjects where I can express myself like English (*F-13-B*)

Recent research by one of us (Bibby, in press) found that towards the end of primary school, expressions of boredom were indicative not only of a lack of stimulation ('fun') but also of a lack of challenge, a loss of control over tasks and direction, and a felt inability to be seen and acknowledged as successful in a subject. There was evidence that the superficial responses to boredom that many primary teachers felt the need to introduce (bright colours, games, easy success) provided little more than titillation, and underestimated some students' desire to engage seriously with intellectual pursuits. Nardi and Steward (2003, 357) also identify a "mystification through reduction" effect, in which teachers, in an attempt to make mathematics simpler, reduce it to a list of rules, and thereby fail to either enhance a proper understanding of the underlying concepts or to provide intellectual challenge. It seems likely that a similar situation holds true higher up the age-range.

While they resonate with Nardi and Steward's (2003) findings of numb disinterest and disengagement from mathematics, our written responses were often charged with emotion:

> Though it may be more interesting than at GCSE, my GCSE maths experience has put me off it for life (*M-13-A*)

> I enjoy it when I get it right, but I didn't choose it because I hate it when I get it wrong and get frustrated (*F-4-A*)

> because it SUCKS and I wouldn't want to spend any more of my time looking at algebra and other crap (*M-13-B*)

> I hate mathematics and I would rather die (*M-13-D*).

In some cases these may be mainly expressing frequent stress caused by experience of a subject where uniquely students can feel completely stuck and unable to proceed with a problem. But across the predicted grade range the anger and violent rejection of mathematics by a few students hints at more troubled stories, some of which (as indicated earlier) are familiar from the literature. Given the examples above, it might appear that, for those with less to lose in terms of the investment/pay-off they experience, it is easier to express extreme anger and hurt. It is more difficult to locate the emotions that lurk under complaints of difficulty, although we might expect some underlying similarities. Sometimes, as indicated above, emotional responses can come to reside with the teacher:

> I despise the way it is taught (*M-3-A*).

Maths is not useful/ not needed by me

It seems that, despite the best exhortations of government and the mathematics education community, messages about the 'vital importance' of mathematics are not being listened to or believed by students. Tebbutt (1993) found that sixth-formers believed mathematics A-level to be less useful for their careers than other science subjects, as well as more traditional, narrow, and less interesting. Quilter and Harper (1988) found that one of the two most important reasons for students failing to continue with mathematics was its irrelevance to the 'real world'. Matthews and Pepper (2005) similarly report that many pupils could not see how mathematics A-level would be useful in later life. This suggests that official messages are either not heard or, if heard, are not convincing.

A small number of students, most of whom had been predicted high grades, said the reason for ruling out mathematics was that the subject was not useful or relevant either for their future degree/career (8%) or more generally in life (3%). Career/ university concerns were most prevalent among predicted A* students, for whom the data in Table 2 demonstrates that this is the most common reason for rejection:

> . I don't think it will take me to where I want to be in life *(M-1-A*)*

A somewhat larger number of predicted A* students said they had not considered mathematics because they preferred other subjects for some reason:

> [I] dropped it in favour of economics as a more real-world related course (*M-13-A**)

Students with predicted grades below A* seemed to find it easier to express angry rejection of mathematics based on their perceptions of the uselessness of the type of mathematics that they were doing in class:

> the amount of insignificant maths work that I will NEVER use is quite big (*M-3-A*)

> who needs to know trigonometry in everyday life? (*F-13-B*)

It would appear that, not only do teachers and government need to convey the usefulness of mathematics generally through the curriculum, but they also need to make sure it is experienced as useful in the classroom.

The particular case of girls

There has been a persistent gender gap in terms of mathematics participation in England, with, for example, males making up 62% of the 2006 A-level entry. This gap exists despite the now very similar achievement of boys and girls in mathematics GCSE examinations at age 16. Our data suggested this gap was still persisting in 2005. It also suggested that proportionately more girls decided against mathematics having considered it, which again suggests that there is considerable potential for recruiting more girls (Table 3).

Previous research indicates that girls hold lower academic self-concepts than boys in relation to mathematics (Kyriacou and Goulding 2006; Elwood and Comber 1996; Woodrow 1996), suffer more from mathematics-related anxiety (Hannula 2002), and may have a more fatalistic view of their lack of ability in mathematics as innate (Dweck 1986, 2000). Their lack of confidence may explain why they are less likely to select mathematics as a specialist subject (Armstrong 1985). There are also institutional hurdles faced by girls interested in mathematics. Not least of these is that, as noted earlier, historically girls have been disproportionately placed in 'Intermediate Tier' groups (Walkerdine 1998; Stobart, Bibby and Goldstein 2005), which removed any possibility of their gaining A and A* grades, or learning the algebra that is important in continued study of mathematics. The under-representation in top sets may be due to a desire to be protective of girls, since there is evidence that some wish to avoid the masculine atmosphere of competition that tends to exist in these sets (Landau 1994; Boaler 1997c, 2002; Bartholomew 2000). It is also possible that it is rather easier for girls than boys to reject the harsh masculinity of top groups without having their gender-identities questioned; indeed, rejecting mathematics may be a way of affirming femininity (Mendick 2006).

Our data on the categories of reasons provided for not continuing with mathematics presented in Table 4 make it clear that lack of confidence is also common among high attaining girls, and broadly supports findings from this literature.

Table 3. Students who considered/intended continuing with mathematics, by gender.

Gender	Male (n = 884)	Female (n = 874)
Considered continuing with mathematics	34%	26%
Intending to continue with mathematics	23%	14%

Table 4. Student reasons for not continuing with mathematics, by gender.

Gender	Male (n = 598)	Female (n = 673)
Too difficult	37%	66%
Do not enjoy/ like it	24%	35%
Boring	12%	15%
Not needed for future degree/ career	7%	10%
Not useful in life	3%	3%
Prefer other courses	2%	3%
Not continuing with education	7%	3%

Note: these are percentages of those students who gave any reason; some gave more than one reason, so percentages may total to more than 100%.

Typical reasons supplied by girls included:

> I feel it would be too difficult at a higher level (*F-13-A**)
>
> because I have no confidence I will get stressed and it will get on top of me and I'm a bit rubbish at it *(F-4-B)*
>
> I don't feel confident enough to do so even if I'm at an A grade (*F-4-A*)
>
> because I don't feel maths is a natural skill – I have to learn it 'by rote' rather than completely understanding it (*F-18-A**).

Similarly the selection of attitude words demonstrate equal percentages selecting words like 'bored' and 'like', about 5% more girls selecting 'hate', but much larger differences in those selecting 'difficult' (42% of girls, 30% of boys) and anxious (35% of girls, 21% of boys).

Results by school

In addition to considering students' reasons for not continuing with their study of mathematics, we also wanted to identify whether some schools in the sample were more effective than others in attracting students to participate in GCE mathematics, and, if so, whether we could gather any clues from the data we happened to have as to why the differences between schools might occur.

Comparing students that were predicted at the same grade across schools, there was a relatively wide variation in the proportion of students intending to continue with mathematics, suggesting that the school attended had a significant impact. This corresponds to findings from Matthews and Pepper (2005), who also discovered strong differences between schools in the proportion of students that continued with mathematics.

Figure 1 shows the mean proportion of students in our own survey that intended to continue mathematics in each predicted grade group, together with the proportions in each predicted grade group from the schools with the two highest and two lowest indices of intended student participation. (For School 1, the results for predicted A and A* grades should be treated with some caution, as they refer to a small number of students.)

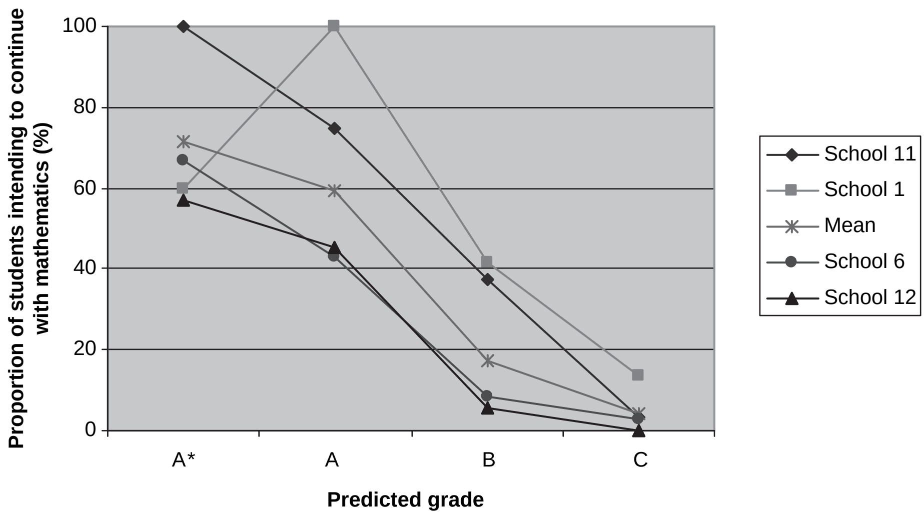

Figure 1. Mathematics participation across different schools.

Because of the strong correlations between predicted grade and intended participation, in comparing the participation rates between schools it was necessary to correct for the differing proportions of students at different predicted grade levels in different schools.

We thus calculated a participation index for each school, by finding the deviations between the percentages intending to continue with mathematics in each predicted grade group in that school and the percentage in the same grade group across all schools, then calculating an average of these deviations across the grade groups, weighted for the proportion of students that were predicted at each grade within each school.

In order to find whether there was any relation between the participation indices for schools and the attitude words chosen by students at the school, we followed the following procedure:

a. We first decided to combine some of the attitude words onto scales of the four constructs 'like', 'enjoy', 'anxious' and 'easy'. This was done partly on the basis of similarities in behaviour across the sample and partly on a consideration of semantics. When combining the words, different weightings were assigned depending on the strength and direction of the attitude that they indicated, e.g., on the 'like' scale, 'like' was awarded $+1$, 'dislike' if supplied was awarded -1, and 'hate', $-$. Similarly on the 'enjoy' scale, 'excited' was weighted at $+2$, 'enjoy' at $+1$, and 'bored' at -1.
b. We could then calculate a score for each construct for each grade level in each school using the percentages of students selecting the words associated with that construct, using the semantic weightings.
c. Because of the correlations between the choice of words and predicted grade level we calculated an index for each construct in each school using the same method as for the participation indices. For each school, we then had four final indices, relating respectively to 'like', 'enjoy', 'anxious' and 'easy', that indicated student attitudes towards mathematics and which were independent

of the distribution of predicted attainment of students in mathematics within each school.

d. We then correlated indices across schools (using the Pearson's Product Moment Coefficient) to see if there was any relation between the index indicating choice of attitude words and the index relating to students intended continued participation with mathematics.
e. The results are shown in Table 5, which also shows the correlations between the participation indices and overall predicted GCSE attainment in mathematics (taken from data in this project).

Strong and significant ($p < 0.05$) positive correlations were found between the extent to which students both 'liked' and 'enjoyed' mathematics in a school and student participation in mathematics. A weak and non-significant positive correlation was found between students' perception of the ease of mathematics in a school and mathematics participation (i.e., the more difficult students found mathematics the lower the participation). Lastly, mathematics participation appeared to be largely unrelated to both anxiety and predicted attainment in mathematics within the schools, once the factor of distribution of predicted grade had been removed from the participation figures. (Very similar results were obtained for those who considered continuing with mathematics as for those intending to continue.) It should, of course, be noted that these correlations do not imply causation; both factors may be explained by other variables such as socio-economic circumstances of students at the school.

We went on to investigate the two schools with the lowest, and the three with the highest, participation indices. In the three highest participation schools, the factors that seemed to influence students' choice particularly, as indicated by their reasons for continuing their study of mathematics, were not consistent between the schools, with the importance of mathematics qualifications, the enjoyment from learning mathematics and career concerns respectively the most prevalent reasons. However, from the attitude word survey, it was clear that students in all three schools were consistent in finding mathematics significantly more enjoyable (and less boring) than the average. This lends further support to the high correlation across all schools found between enjoyment and participation at the school level.

In the two schools with lowest participation indices, students were particularly negative about the difficulty and boring nature of mathematics, even after the correction for distribution of attainment had been made. These were also the schools with lowest attainment (judged in terms of actual predicted grades, or percentage of

Table 5. Correlations between school attitude and participation within mathematics.

	School index for student attitude towards mathematics				
	Like	Enjoy	Anxious	Easy	Predicted attainment in maths
Correlation with student intended participation	0.59	0.65	−0.04	0.10	−0.07

students gaining five A*–C grades at GCSE) as well as having the lowest absolute participation rate. There was no support for the hypothesis that students predicted grade B were more likely to be discouraged from continuing with mathematics in schools with a significant 'clever core' of students predicted to get A* and A grades; in fact the opposite seemed to be the case.

We also checked the reports by Ofsted inspectors on the mathematics teaching in all five schools; in three cases out of the five, the comments about the quality of teaching seemed to support our findings about enjoyment.

In the previous section we found, looking across all the individual students in the sample, that perceived difficulty was commonly cited as a major reason for their rejection of further study of mathematics, although lack of interest, or perception of mathematics as boring, was also a strong contributory factor. However, when we looked for something which seemed to explain the considerable differences between schools in their participation indices, what differentiated schools very clearly was the mean level of student scores on the enjoyment scale (which included the selection of the words 'excited', 'enjoy' and 'bored'). This corresponds to the finding at age 11–14 that 'fun' is the key aspect for students of effective mathematics teaching (Steward and Nardi 2002). The replacement of difficulty by enjoyment, the key factor for students as that differentiates school participation indices, may be because perceived difficulty is a more individual factor, or one which may arise from the specific teacher or the interaction of the individual and the teacher, whereas perceived emotional state may be more characteristic of the culture or ethos of a whole school.

Possible ways forward

At the start of this article, it was noted that there was general agreement in education and government that, for perceived economic and continuity reasons, England needs more students to study mathematics beyond compulsory levels. The data presented here is similar to that provided by Matthews and Pepper (2007) in suggesting three partially overlapping groups from which there is most potential to recruit additional students:

a. students with grade B, or possibly C, at GCSE, who think mathematics is too difficult;
b. girls, at all levels, who lack confidence in their own ability;
c. students with high GCSE grades, who are either not very interested in mathematics or do not appreciate its importance.

The results of this study, in line with previous studies, suggest that the main factor deterring these students is the perceived difficulty of the subject, based either on previous experience as learners or on sources informing future expectations, with older students (including siblings) and teachers being two of the most important. Although the recent rise in numbers suggests that changes made after *Curriculum 2000* have helped to reduce the level of difficulty of AS mathematics in particular, the general impression is still that students need at least a B grade in GCSE, and preferably an A or A*, to cope with the step up in difficulty. Therefore, solutions to the problems of participation clearly need to address the attitudes of teachers and older students, as well as those of 16 year-old students.

One set of possible strategies seems to lie in dissolving the *structural* barriers to mathematics, which are mainly concerned with reducing hierarchies in curriculum, assessment structures and grouping methods, and with finding incentives for national bodies, institutions and teachers to try to remove the current barriers which students perceive.

Another set of strategies might attempt to deal with dissolving the *personal* barriers to mathematics, confronting the tendency we found in this study to feel that there are innate boundaries to their progress, and to increase confidence and self-efficacy, encouraging more positive pupil identities with respect to the subject. In doing this there are warnings from Nardi and Steward (2003) and Bibby (in press) that trying to protect students from challenge is more likely to result in boredom than in positive engagement and attitudes. Trying to take the challenging sting out of mathematics is neither possible nor desirable: challenge and confidence will always be in tension, with no resolution. As Britzman reminds us:

> In *Civilisation and its discontents,* [Freud] warned educators that idealising the world for children and promising them happiness in a life without conflict would only incur helplessness and future disappointment (2003, 2)

Finally although the study had insufficient data on the schools attended to draw any very firm conclusions, there was an interesting hint of some evidence in the data that one of the most effective strategies a school can adopt to increase its participation rate, in addition to dissolving institutional barriers for students, is to increase the enjoyment and excitement of teaching pre- and post-16, and to reduce the boredom levels. No-one is pretending that this is easy, especially in countries such as England, where mathematics teachers are held accountable mainly in relation to attainment data. Perhaps if the national participation targets were to be translated to local and school targets, there might be more incentive to prioritise participation, as well as attainment.

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