'I WOULD RATHER DIE': ATTITUDES OF 16-YEAR-OLDS TOWARDS THEIR FUTURE PARTICIPATION IN MATHEMATICS

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Questionnaire responses were analysed from 1997 GCSE mathematics candidates in 17 schools about their expected future participation in AS/A level mathematics, their reasons for this and their attitude to mathematics. The data was gathered as part of a larger study but was analysed separately. The analysis supports findings from previous studies in demonstrating that lack of confidence and perceived difficulty are the major reasons for students not continuing with mathematics, and that dislike and perceived lack of relevance are also factors. The study shows a clear relation between these factors and predicted GCSE grade, and a lesser relationship with gender. When these were corrected for, school participation rates still varied, with enjoyment differentiating schools with high and low participation rates.

POLICY BACKGROUND

This research contributes to an issue which is currently recognised by the government as a key one: the need to increase participation in mathematics in post-compulsory education. The Roberts (2002) report *SET for Success* noted a rising demand for those qualified in science, engineering, technology and mathematics against a declining supply. For example, updating to 2003 figures, mathematics A-level entries were down by 28% between 1982 and 2003, and while there has been a small increase since then the numbers have still not yet even reached the 2001 level. Those students selecting the combination maths/ physics/chemistry dropped even more catastrophically, by 45% between 2001 and 2003, as a result of the introduction of *Curriculum 2000*. Roberts noted that this decline had led to more than 25% of universities closed departments in the STEM subjects.

The attention to the key role of mathematics paid by Roberts, although this subject was not in the brief, was soon followed up by the Smith (2004) Report *Making Mathematics Count*, also announced and funded by the Treasury, but managed by the DfES. Smith stressed the national need for more young people to study mathematics for longer, and suggested that this could be achieved by wider recognition of the importance of mathematics, improved teacher supply and professional development for teachers, and changes in the curriculum and qualifications pathways so as to provide appropriate progression for all students.

A key Treasury (2006) response to the Roberts and Smith reports was a paper issued as part of the Budget papers, *Science and innovation investment framework 2004-2014: next steps*, which set targets for increasing the A-level passes in mathematics, physics and chemistry (for mathematics the targeted number is 56 000 from a base of 46 168). This was to be accompanied by additional investment in STEM education, managed by a new committee structure now emerging.

RECENT RESEARCH BACKGROUND

There have been a perhaps surprisingly large number of research studies in the area of participation in mathematics over the years (e.g. Cheng *et al*., 1995; Sharp *et al*., 1996.) Research up to 1997, mainly from the UK but some from other Anglophone countries, is reviewed in Osborne et al., (1997). The general fndings are that the main reasons why mathematics is not selected is because it is 'hard' and 'boring'. More recently the negative attitudes have been described in detail at KS3 by Nardi and Steward (2003) who found that mathematics was perceived as *tedious*, with too much *individual* work, *rote-learning*, *elitism*, and was *de-personalised (T.I.R.E.D.)*. This was attributed to too much teaching to the test and not enough aimed at engaging and inspiring students, descriptions also supported by a recent Ofsted report (2006) on the teaching of mathematics in the 14-19 age range.

Matthews and Pepper (2005), in the interim report of a comprehensive QCA-funded research project on participation in AS- and A-level mathematics, suggest that the major cause of poor take-up is that students do not feel that they are good enough to continue, and in particular that they are not members of the *clever core* (an effect similar to Nardi and Steward's *elitism).* There were also considerable differences between schools in what proportion of students did, and were encouraged to, continue – some schools only accepted students with A grades or from 'the top set', whereas others welcomed students with B and C grades. Gender differences were noted with regard to motivation for continuing with mathematics, with *utility* being a more cited reason by males (who formed 62% of the group), and *comfort* (confidence/enjoyment) by females. Mendick (2006) explained the gender differences by noting that mathematics is identified with masculinity.

A systematic research review on increasing motivation for mathematics at KS4 (Kyriacou and Goulding, 2006) had similar findings and suggested that the most effective strategy to enhance participation rates would be to enhance self-confidence (create a positive identity), but that making the curriculum easier might also help.

RESEARCH DESIGN

The data for the research was taken from a study evaluating the 2005 pilot and trial of new two-tier GCSE maths examinations. Other aspects of the data are reported by Stobart, Bibby and Goldstein (2005). This study was partially based on an eight-page questionnaire given to students in Year 11 asking about their experiences of the different examination systems as well as their attitudes towards mathematics. The questionnaires were sent to schools and filled out by students in the period after they had taken their GCSE examinations, but before they had received the results.

This report is based on answers given by the students to part of the questionnaire. This data was not analysed as part of the funded study but the analysis was later undertaken separately, funded jointly by King's College London and the Institute of Education. The relevant questions concerned:

1. Gender and predicted grade at GCSE
2. The attitude words students associated most with mathematics. They could either ring one or more of the ten descriptive words that had been provided in the questionnaire (enjoy, like, hate, excited, bored, frightened, anxious, worried, difficult, easy) or insert their own descriptions. There was no limit to the number they could ring/ provide.
3. Whether students were continuing their studies at AS-level and, if so, which subjects they were intending to take.
4. Whether they had considered continuing with mathematics.
5. The reasons for them considering or not considering continuing with mathematics. This was an open question so students could provide any reason(s) they wished.

The sample consisted of 1997 students from 17 schools (although for the words describing mathematics some changes were made to the questionnaire so that for those results the sample is only the 427 students from 5 schools who had the improved version). The choice of schools was dictated by the awarding bodies involved in the study and their selection of schools. Although these are therefore not a representative sample, they did cover a good geographical spread across England and Wales and a good size range (between 106 – 410 pupils at end of Key Stage 4). In addition, there is a reasonable range of school types including one single sex boys' school and two faith schools. (The single sex boy' school is not included within results on gender differences.)

The percentage of pupils achieving five or more A*-Cs ranged between 30 – 85% in the different schools with a mean of 65%. This compares to a national average of 56.5%, indicating that the sample of schools is significantly above average in terms of overall attainment at GCSE, even though some lower attaining schools were included. This was also true when the distribution of predicted grades in mathematics was compared with national GCSE results. This needs to be borne in mind in interpreting the results.

RESULTS

In this section a selection of the results will be presented. Because of space limits the graphs illustrating them are not included but only the main trends.

1) Both the proportion of students who considered continuing with mathematics and those who intended to continue not surprisingly decreased with declining grade level, with a particularly marked dip from those predicted at grade A to those predicted at grade B. Less than 20% of the predicted B's, but almost 60% of the predicted A's, and almost 70% of the predicted A*'s, intended to continue with mathematics. The predicted B's who intended to continue were also a much smaller proportion of those who had originally considered it than was the case at A and A*.

2) The major reasons for those predicted at grades A* to C for intending to continue to AS/A level in mathematics were, in decreasing order:

   - enjoyment of the subject,
   - appreciation of its usefulness for a career,
   - confidence in the capacity to succeed,
   - a view that it is important and/or provides important skills.

   While the proportion of students citing enjoyment was fairly steady across grades, proportionately slightly more of the lower grades felt that career reasons were significant and slightly fewer felt that it was generally an important subject. Confidence in their own ability to succeed given as a reason not surprisingly fell dramatically from higher to lower grades.

3) The major reasons for not continuing in decreasing order were that mathematics was perceived as :

   - too difficult,
   - not liked/enjoyed,
   - not needed for an intended degree or career,
   - boring.

   Again the reasons differed by predicted grade, with most A*'s citing its lack of relevance to their future plans, and lower grades mainly suggesting that it was too difficult or not liked. Perceived boredom was cited as a reason by between 10% and 20% at each grade level.

4) Words ticked or supplied to describe mathematics similarly varied across predicted grade levels with A*s overwhelmingly citing predominantly 'enjoy', 'like' and 'easy' with few other choices and C's citing 'bored', 'difficult' and 'anxious', followed closely by 'like' and 'hate'. 'Bored' was the most frequently ticked word overall, selected by 37% of students.

5) Gender was also related to responses, with over 30% more boys having considered continuing and about 50% more intending to continue. Girls were significantly more likely to continue because they enjoyed it and slightly less likely to give careers or confidence as reasons. Girls were far more likely to give difficulty or dislike as reasons for not continuing, and slightly more likely to say it was not needed for their degree/career or that it was boring. In the word-choice the main differences were that girls more frequently associated mathematics with difficulty, anxiety and hatred.

6) Further insight was obtained about these rather broad categories by analysing the free response sections. For example:

   - The 'too difficult' response partly reflected a belief that only students with A or A* at GCSE could succeed at AS/A level, a belief that seemed to

derive more often from older friends, other students, or family members with recent experience than from teachers. The lack of confidence in their own ability was not confined to students with lower predicted grades; some predicted to get A*, especially girls, did not feel they were good enough. Some felt that they already relied too much on rote learning and had insufficient understanding, or believed it was too high a step from GCSE.

- An interesting perception was that each person has a fixed ceiling of understanding above which they can't go, so if there were things that students did not understand at GCSE they felt they would not understand anything at AS level. These students did not appreciate that the ceiling might move upwards as they proceeded to learn. A perhaps related point was that 5% of students ticked both 'easy' and 'hard'; some explained that mathematics was easier than other subjects until you hit the ceiling of understanding when it suddenly became much harder.
- 'Boring' was sometimes interpreted as a lack of opportunity for creativity and self-expression, but some students invoked much more negative emotions of hatred and frustration.
- While students with higher predicted grades tended to feel that mathematics was prestigious, well-regarded by universities - if only as a proxy for intelligence and status - and useful to support other subjects, other students felt that mathematics was a waste of time as they were unlikely to ever use much of the mathematics they had recently learned.
- A minority of students described their experiences of poor teaching and lack of continuity with a series of supply teachers and attributed their lack of interest to these factors.
- Enjoyment of mathematics was explained as relating to different aspects of the subject, in particular its inherent logic, and problem-solving activity.

7) In comparing participation rates between schools, it was important to correct for the proportions of students predicted at different grade levels. Having found a way to do this, clear differences emerged; some schools had more and some less participation, and this tended to be consistent across all grade levels. It was found that at school level there was a link between participation rates and the proportions of students citing enjoyment, but it was difficult, maybe because of insufficiently reliable data, to find a relation between participation and teaching styles/quality (using Ofsted reports).

DISCUSSION

Many of these findings reflect those in previous studies, but the free response items give additional insight into some student perceptions. It is clear that providing students with more confidence in their abilities and with more enjoyment of lessons should be the first move in increasing participation, and that students with B grades

and girls could provide target groups with particular potential. Better marketing of the importance of mathematics among some groups, and its usefulness as a support for other degree subjects, seemed likely to be effective.

REFERENCES

Cheng, Y., Payne, J., & Witherspoon, S. (1995). *Science and Mathematics in Full-time Education After 16: England and Wales Youth Cohort Study.* London: Department for Education and Employment.

H M Treasury/DTI/DfES/DH (2006) *Science and Innovation Investment Framework 2004-2014: Next steps.* London: HMSO.

Kyriakou, C. & Goulding, M (2006) *A systematic review of strategies to raise pupils' motivational effort in Key Stage 4.* Mathematics. London: EPPI-Centre.

Matthews, A. & Pepper, D. (2005) *Evaluation of participation in A-level Mathematics: Interim report.* London: Qualifications and Curriculum Agency.

Mendick, H. (2006) *Masculinities in Mathematics*. Maidenhead: Open University Press.

Nardi, E. & Steward, S. (2003) Is Mathematics T.I.R.E.D.? A profile of quiet disaffection in the secondary mathematics classroom. *British Educational Research Journal*, 29(3), 345-367.

Ofsted (2006) *Evaluating mathematics provision for 14-19 year olds.* London: Ofsted.

Osborne, J., Black, P., Boaler, J., Brown, M., Driver, R., Murray, R., et al. (1997). *Attitudes to Science, Mathematics and Technology: A review of research.* London: King's College, University of London.

Roberts, G. (2002) *SET for Success: The supply of people with science, technology, engineering and mathematical skills.* London: The Stationery Office.

Sharp, C., Hutchinson, D., Davis, C., & Keys, W. (1996). The Take-Up of Advanced Mathematics and Science Courses: Summary report. London: School Curriculum and Assessment Authority.

Smith, A. (2004) *Making Mathematics Count.* London: The Stationery Office.

Stobart, G., Bibby, T. & Goldstein, H. (2005). *Moving to two-tier GCSE mathematics examinations: An independent evaluation of the 2005 GCSE Pilot and Trial*. London: Institute of Education, University of London.