Mathematics: Breaking Down The Barriers

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Introduction

This paper summarises the results of a UFC funded project run at the University of Exeter which investigated whether the mathematics GCSE requirement for courses such as teacher education and some social sciences is a barrier to higher education for adult returners on Access courses. Access students are not a homogeneous group so we also questioned whether, if mathematics was a barrier, this was for all Access students or just for particular, identifiable sub-groups. Further and more detailed results of the project have been published in two papers by Roseanne Benn and Rob Burton in 'Access mathematics: a bridge over troubled waters' Journal for Access studies 8(2) 1993 and 'Access and the mathematics deterrent', Studies in the Education of Adults, 26(2).1994.

Research design and methodology

Two questionnaires on attitudes to mathematics, one for students and one for staff, were tested in a pilot survey then sent to 109 institutions offering Access to Social Science and Humanities courses (20% national sample) and Access to Teacher Education courses (100% national sample) in England, Wales and Northern Ireland.(Jones 1992) The sample returns were: Access to Social Science and Humanities courses, 70 courses sampled, 91 per cent (64) returned; Access to Teacher Education, 39 courses, 72 per cent (28) returned. The overall return was 84 per cent. Individual returns from the students were: Access to Social Science and Humanities, 53 per cent; Access to Teacher Education, 54 per cent. The return was 54 per cent with a total of 1471 returns. Forty five tutors replied, giving a response rate of 41 per cent. This lower rate of return reflects the fact that not all Access courses have mathematics tutors.

The questionnaire had three distinct sections. Firstly, we were interested in the level of mathematics of Access students on leaving school and their general level of education. Secondly, using simple attitude scales, students confidence in specific areas of Mathematics was tested. A Likert attitude scale[1] was developed to test whether Maths was a barrier to Higher Education. The attitude scale consisted of ten questions which were piloted and the internal reliability tested using the Cronbach alpha.[2] For the total population studied the Likert attitude scale has a Cronbach alpha coefficient of 0.8552 and hence is statistically valid and has internal reliability. Finally we asked our students a number of questions to establish their social characteristics. The questionnaires were completed in the second half of the Autumn term, 1992.

1 The Likert scale is a unidimensional scale. Equal numbers of negative and positive questions are used to arrive at a 'summated' score.(Likert 1932) In this case 0 suggests mathematics presents no barrier and 40 suggests Mathematics is seen as a high barrier to higher education.

2 For further information concerning the Cronbach alpha, see De Vaus, (1990) pp.88-89.

Analysis and findings

Student attitudes

First, we were interested in Access students' levels of mathematics confidence. When asked their feelings upon finding out that they needed the mathematics qualification, students were uninhibited in their negative responses. We established the outcome of eleven plus years of compulsory mathematics schooling by asking for the level of mathematical qualification on leaving school and whether the student had encountered any particular problems with school mathematics. Low levels of mathematics achievement seem to be a shared experience for those who responded to our questionnaire. Approximately 35% of our sample reported that they had left school with no mathematical qualifications and a further 49% less than O level equivalence. When asked to comment whether they had particular problems with their school mathematics, a worrying 80% of our sample responded in the affirmative. Many of these students were of the opinion that they had been let down by the school system and reported problems of both lack of understanding and communication with the teacher. A significant 84 per cent of our cohort had a low or no mathematics qualification and many showed a negative attitude to school mathematics.

The overall context in which an Access student's attitude to mathematics must be set is a very strong motivation to get into higher education. Over 80% agreed that, whatever the requirement for entry, they would have attempted to get it. But another important factor to emerge amongst at least some of the group was a positive attitude to mathematics itself and a growing sense of confidence. Almost half the students agreed that they enjoyed mathematics, with over half feeling reasonably confident in tackling mathematical problems. Again half perceived no problems in understanding mathematics. Although the subject brings 30% out in a cold sweat, it does not have that effect on a sizable 60%. This shows approximately half the cohort enjoying mathematics and feeling confident with no major difficulties or fears. There is an undecided or wavering group of 10%-20%, with 20%-30% with negative feelings in this area.

The authors' experience in teaching mathematics on Access indicates that there is an appreciable number of students who wish to study mathematics for their own personal satisfaction and development. This is borne out by the 44% of the sample who agreed that they were taking mathematics for their own satisfaction and the 60% who saw mathematics as an important part of their development. A further indication of confidence in mathematics was given when 60% agreed that they would apply for a higher education course with a mathematics entry requirement and only 17% saying that they would not. It must be remembered that this result is probably skewed by the respondents on Access to Teacher Education courses. However a perhaps surprising but similar 60% would even apply for a higher education course that had a mathematics component. If offered another route into higher education without a mathematics requirement, 42% would take it but a significant 36% would not.

The results of our study seem to suggest that once people have made up their mind to enter higher education, perhaps to study for a particular career such as teaching, then the psychological barriers concerning mathematics seem to have been broken. The results above seem to suggest there is a widespread mathematics anxiety that is linked to a lack of understanding. This lack of understanding or bewilderment is quite common in mathematics (Buxton 1981 p109), but for mature students on Access a

combination of motivation and positive teaching methods work to reduce these earlier fears.

Tutor perceptions

When asked whether the mathematics GCSE requirement is a barrier, two thirds of tutors thought it was. Of these, three quarters identified it as a high barrier. Clearly most tutors perceive this requirement as a serious obstacle to progression. This opinion however does not seem justified by an examination of the previous year's results. In over half the replies, no student was identified as having not progressed to their chosen exit or course because they had not obtained the appropriate mathematics pre-requisite. In two thirds of the replies only 5% or less of the students had not progressed due to their mathematics. These very positive results were echoed by the feeling of many tutors that the student group as a whole had made considerable strides in their mathematics over the Access year. When asked how many students in the previous year had a serious problem with mathematics, early in the course, over three quarters of the tutors gave a figure of 20% or more, late in the course half the tutors thought that the number with serious problems was 10% or less.

The care and commitment of tutors shines through their comments. They report that the key quality of their teaching is encouragement and understanding; that tutors need to be patient and remove the often difficult and disabling pressures of time and that Access mathematics needs to be taught in context and have a relevancy to real life and other parts of the course. They note that the involvement of students and tutors in free discussion and dialogue in a supportive atmosphere helps students develop confidence. Students on Access mathematics are clearly coming on to courses with long memories of bad experiences at school. This has many causes - bad teaching, lack of understanding and a lack of relevance to their own lives. Access tutors in recognising this have geared their approaches to reduce much of the anxiety and panic students feel.

This new found confidence in mathematics has wider effects. One tutor noted that by making progress with a subject they had thought they were unable to do, Access students gained an enormous sense of achievement and increased confidence which informed their whole approach to study.

We hence concluded that students are arriving on Access with considerable anxieties about mathematics often based on bad school experiences; that the approach taken by tutors is critical in how students perceive mathematics and how they accomplish what is for some a difficult subject, both emotionally and practically; and that the provision of a mathematics component in an Access course has a number of enabling roles for the students.

We now extend this analysis by considering the mathematics requirement with particular reference to the constituent groups in Access. The social classifications considered were gender, class, age, race, those with little in the way of formal qualifications, and those with no mathematics qualification. The first and most obvious conclusion to draw from our results was that there is a sizable proportion of each group that considered mathematics to be a high barrier for themselves and this is true whether the question is asked directly or indirectly. Earlier we showed that these attitudes were being changed for those on Access courses. Nevertheless these figures indicate an area that must concern all Access providers. It is also important to note that respondents express more concern when asked directly if mathematics is a barrier. This is perhaps

not surprising as the very question may cause them to recall not only their own experiences and fears of mathematics but also the negative views of mathematics within our society. We shall now consider each subgroup separately.

No Mathematical Qualification

It comes as no surprise that people with no mathematics qualification upon leaving school see mathematics as a barrier to higher education and exhibit the highest levels of anxiety. Again this poses a dilemma for access providers. Access is premised on the notion of open entry but it is clear from both our statistics and an analysis of individual comments that some people are entering or considering entering Access with very low levels of mathematical knowledge. Some of these people wish to progress to teacher education or the social sciences and so need the mathematics qualification. It is noted from sources such as the Cockcroft Report (1982) that learning mathematics takes time. Indeed Cockcroft notes that 'A frequent complaint [from students] has been that insufficient time is given to curriculum and method work'(ibid p.209). Tutors on Access also recognise the constraints time imposed upon their students' mathematics development. It may be that people in this group should be counselled to take a mathematics course prior to Access or seriously consider alternative routes that do not require mathematics.

Low Level of Non-mathematical Qualifications

The authors had anticipated that this group might see mathematics as a high barrier but they showed no exceptional problem.

Gender

It is clear from our results that women on Access, whether asked directly or indirectly, show more anxiety about mathematics than men. There are many cultural explanations for this. Women and girls are discouraged from studying mathematics because of its masculine image (Astin and Myint 1971; Rose and Elton 1971; Trecker 1971; Walkerdine 1989). Ironically girls at high school fail to view mathematics as important to them for their later careers (Pedro et al 1981; Wilson and Boldizar 1990). This, as Fennema and Sherman (1977) and Sherman and Fennema (1977) have shown, has a major effect on females' confidence with mathematics both at school and in later life.

It would seem that both at Open Days and in early mathematics sessions on the Access course, tutors need to discuss these cultural experiences and expectations with both men and women to raise awareness in the students that earlier failure in mathematics may be due to this socio-cultural reality rather than their own inadequacy.

Race

In the Access group, 7.8% were Black which compares well with the 5.5% for the whole population in the 1991 Census. As a group, Black people showed the same score as White people on the Likert Scale, with Africans and Carribeans showing higher anxiety when the group is broken down.The results of the direct question about mathematics as a barrier indicated greater problems for the Black group. Each sub-group of Black minorities had a higher percentage stating that mathematics was, for them, a high barrier than for the cohort. Although some of the group sizes are small, this indicates a worrying trend.

Age

Our results do not indicate a clear correlation between age and anxiety about mathematics.

Class

Empirical research has traditionally used the Registrar General's (RG) classification of occupations as the method of classifying people in the social structure. However, past theoretical and research debates concerning social classification and women (Stanworth 1984; Middleton 1974; Ritter and Hargens 1975) would suggest that perceptions of women on Access gained through use of this classification may not bear close relation to reality. Work on this project published elsewhere (Benn and Burton 1993b) agrees with this contention and hence we do not feel able to draw any conclusions on whether links exist between class and anxiety with mathematics.

Implications for Access.

Bad experiences at school for many students raise grave personal doubts about their ability not only to do mathematics but to succeed in post-secondary education at all. We showed, however, that the commitment and considerable skill of Access mathematics tutors work to reduce these anxieties and help students to fulfill their goals. We have identified the particular social groups who find the mathematics requirements of Access and of their future chosen careers a barrier or deterrent but note that there is a sizable proportion of every subgroup that considers mathematics to be a high barrier for themselves. To reduce this deterrent factor, practitioners need to constantly consider admissions procedures and processes and monitor their approach to the mathematics component. Certain groups of students are particularly vulnerable and these may need special attention. It is crucial to widen access but not to have Access students fail yet again because of the pressure of the mathematics component of the course.

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