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Mathematics Support – Support for all ?

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Abstract

Mathematics Support Centres are to be found in various forms in the majority of UK higher education institutions. They have been established in order to ease widespread and serious difficulties that a significant number of students have with mathematics, particularly at the school-university transition. They usually offer mathematics and/or statistics support to students across the full range of disciplines studied. Anecdotal evidence suggests that those students who make good use of such centres are not just those who struggle with mathematics. Many frequent users are quite competent and simply *want to do better*. The study reported here describes and analyses data from one cohort of engineering students. A novel aspect is the quantification of the proportion of support centre visitors who fall into these, and other, categories. We conclude of the cohort in the study, mathematics support has improved the pass rate by approximately 3%. Of the failures, about half (approx 4% of the sample total) could well have passed had they attended the mathematics support centre regularly. Furthermore, the majority of those attending were not students who were in danger of failing. This has important implications not only for the design of mathematics support provision, but also for the performance of the high fliers. The methodology offers one way tackling the difficult task of evaluating the effectiveness of mathematics support initiatives.

1. Introduction

The decline in the level of mathematical skills displayed by students upon entry to universities in the UK has been well documented in numerous learned society, professional body and research reports [1,2,3,4]. The problem has been recognised at the highest levels in government and various initiatives have been instigated which are beginning to try to address the problem [5]. It is widely accepted now that students' lack of preparedness for the mathematical demands of higher education is now affecting all universities, at least to some extent [6]. Traditional users of mathematics, e.g. engineers and physical scientists, are at the sharp end of the problem, but there is mounting evidence that a surprisingly wide range of other disciplines are finding that students' lack of basic mathematical skills is causing problems for them too [7,8]. Consequences for students include disillusionment, failure, withdrawal, and loss of self-esteem; for staff there is increased pressure and lack of job satisfaction. This situation forms a vicious

circle, reducing further the pool from which future mathematics teachers might be drawn. For institutions, failure and withdrawal of students represents a loss of income, and deterioration in league table positions.

Higher Education institutions have responded in a variety of ways to tackle these challenges. A detailed overview of efforts can be found in the publications arising from the LTSN MathsTEAM project (http://mathstore.ac.uk/mathsteam/. One approach is through the provision of mathematics support centres. These vary in scope and size from small operations involving perhaps one keen member of staff on a part-time basis, to fully-fledged university wide centres. Two centres that are widely quoted and acknowledged as leaders in this field are those at Loughborough and Coventry Universities. Together, these centres form **sigma** which has achieved *Centre for Excellence in Teaching & Learning* status from the Higher Education Funding Council for England. As in many mathematics support centres, students from across the full range of courses on offer at these two universities can drop-in to access one-to-one support and resources. The data used in this study are drawn from students using the Loughborough centre. In 2004 a survey was conducted to determine the extent of mathematics support provision nationally [9]. This found that of 106 UK universities in the study, 62.3% offered some form of learning support in mathematics *over and above* that normally provided through lectures, tutorials, personal tutor groups and problem classes. The authors are aware that since 2004 several other universities in the UK have opened mathematics support centres.

Clearly the sector is making significant investment in this growing field. A perennial challenge for those running support centres is to acquire convincing data that such investment and effort is worthwhile and worthy of continued funding. Doing this is not trivial – some students visit support centres just a few times, but find these visits helpful. Others are regular users. It is impossible to say with any certainty that because a student makes good use of a centre their subsequent success in mathematics can be attributed to the work of the centre. There are so many factors involved – student ability, motivation, who is teaching the course, changes in entry requirements and syllabi, requirements and different practices of academic departments, and so on. These change from year to year, and moreover, support centres usually operate outwith the student's home department. Nevertheless some attempt at evaluating success is necessary. A commonly used evaluation mechanism is the feedback form – students complete such forms after using the centres. Generally, the comments made are very positive because it is usually the case that staff working in the centres are trying hard to help, and students acknowledge this. So whilst pleasing, the results are not surprising, and thus don't really reveal very much. Usage data is usually kept, and a centre which is well-used is clearly satisfying student demand. What usage data does not indicate is the affect if any, on student performance. What would be much powerful would be quantitative data on how those who use the centre perform in their mathematics examinations, and whether failing students are those who do not make use of the centre.

Generally, support centres have been set up to help those students who struggle at the school/university interface. However, there is anecdotal evidence that

(a) some of the students most in need of support fail to access it at all,
(b) many of the students who make good use of support centres are those who would pass the mathematical components of their courses anyway,

(c) there is a group of borderline students for whom mathematics support is key to their success.

In July 2007, the UK government's National Audit Office (NAO) published a report [10] on the retention of students within Higher Education. Although the report was not specifically targeted at the mathematical sciences, there are several areas where it recommends that an institution can target its work in order to make a difference to student retention. In particular, the report describes that the approach to retention should be a positive one, and that it should provide students with opportunities to improve their grades rather than just addressing any gaps within their knowledge. The data we will present provides evidence that mathematics support centres are already doing just this - enhancing the undergraduate experience for many centre users, not just those in danger of failing. It will provide a novel analysis which attempts to provide a more substantial evidence base for the value of our work than that provided by feedback forms and usage data.

2. Data and discussion

We have been interested in gathering and analysing data that is intended to substantiate the anecdotal evidence referred to in the previous section. The study described here attempts to disentangle the groups of students who are likely to fail without mathematics support, those who fail but don't bother to access it, and those who would have passed anyway, in order to gauge the extent to which they access support and the extent to which it is successful. We have achieved this through analysing the end-of-semester mathematics results for five first year engineering mathematics modules taken in the academic year 2004-2005. The total number of students involved was 644 and for each student we have information on their mathematics module grade: A, B, C, D, E and F where D is the pass threshold representing a final module mark of 40%. Data collected in the mathematics support centre throughout the year included information on whether each of these individuals had visited the centre, and if so, the number of visits they made. There are important factors that we have not been able to include in our analysis. For example, we did not have access to data on students' entry grades – academic departments are particularly sensitive to releasing such data. Because of the large number of centre users we do not routinely collect data on the amount of staff time required by individual students nor on the problems being tackled, which can be very diverse in nature and level. With finite resources, there is always a balance to be met between the amount of effort expended on first-line support, and effort expended on data gathering and analysis.

The data collected for this paper comes from the 2004 year 1 mathematics modules for several engineering departments at Loughborough University; Electronic and Electrical Engineering (year long), Civil Engineering (semester 1) Aeronautical and Automotive Engineering (semester 1), Civil Engineering (semester 2), Mechanical Engineering (year long). We are presenting just headline data. In what follows, these modules have been labelled a,b,...e. We have gathered and analysed data on both the number of students who visited the support centre and also the number of visits they made. The results of this analysis are presented below.

Table 1 gives the number of students on each module, by gender and origin. All the modules are predominantly attended by British males with female and overseas students accounting for approximately 10% and 7% respectively.

Module	Gender		Nationality		Visit Frequency		
	Male	Female	Home	Over-seas	0-1	2-9	10+
a (120)	108	12	108	12	91	23	6
b (125)	109	16	114	11	88	33	4
c (127)	118	9	119	8	121	6	0
d (130)	113	17	119	11	103	24	3
e (142)	131	11	136	6	107	27	8
Total (644)	579 (90%)	65 (10%)	596 (93%)	48 (7%)	510 (79%)	113 (18%)	21 (3%)

Table 1. Student visits to the mathematics support centre by module.

Table 1 also gives details of the number of visits to the support centre that these students made. With reference to the number of visits we have grouped these as 0-1 visit, 2-9 visits and 10+ visits.

It has been necessary to make some assumptions:

1: that whilst students may have received significant assistance from a single visit, students who have made only one visit do not feel the need for mathematics support. It is, of course, possible that such students found their first visit disappointing and decided not to return again. We believe this to be unlikely, and certainly not the case for most students.

2: that students who have made between 2 and 9 visits are attending regularly for help with specific topics and are finding this useful.

3: that students who make ten or more visits represent either those struggling with mathematics or those who use their very regular attendance at the centre as a comfort blanket.

4: that attendance at the mathematics support centre can only serve to improve a student's module mark. Attending students do not perform *worse* in examinations than if they had not attended.

For year long modules we have counted all visits during the academic year. For semester long modules we have counted the number of visits during the particular semester. So, for example, on module b 33 of the 125 students visited the centre for mathematics support between 2 and 9 times in the semester prior to their examination. From Table 1 it will be seen that module c has the lowest level of attendance at the mathematics support centre; students on this module are recruited with the highest 'A' level points. So, with the exception of this module, over 20% of students in our study attend the centre regularly for specific assistance, with a further 3%-8% being very regular visitors.

Table 2 gives the end of semester (or end of year) module grades and number of visits to the mathematics support centre for the students on each module.

Module	Visits	Grade							Total
		A*	A	B	C	D	E	F	N
a (120)	0-1	7	13	19	14	19	10	9	91
	2-9	7	3	6	2	0	1	4	23
	10+	0	1	1	0	2	1	1	6
b (125)	0-1	16	12	16	15	11	10	8	88
	2-9	17	3	6	3	2	1	1	33
	10+	3	0	0	0	1	0	0	4
c (127)	0-1	25	35	31	24	5	0	1	121
	2-9	2	1	1	1	1	0	0	6
	10+	0	0	0	0	0	0	0	0
d (130)	0-1	9	12	27	18	22	5	10	103
	2-9	5	4	4	4	7	0	0	24
	10+	1	1	0	0	1	0	0	3
e (142)	0-1	12	23	21	24	17	3	7	107
	2-9	2	5	9	5	4	2	0	27
	10+	0	1	2	2	3	0	0	8

Table 2. Attendance at the mathematics support centre by module and module grade achieved.

From Table 2 it will be seen that the number of students attending mathematics support more than once who obtained a D grade is 21 (3%). These students have taken advantage regularly of mathematics support opportunities offered to them, and have just succeeded. It can be assumed, therefore, that these are students who are the most likely to have failed without support.

The number of students who attended mathematics support more than once and failed is just 11. These are students who are clearly trying but who find the mathematical demands of their programme, even in the presence of regular mathematics support, to be too demanding. More significantly 63 (10%) students who failed did not attend the mathematics support facility more than once, of which 28 (4%) obtained a grade E. This latter group would be likely to have passed with regular mathematics support, thus indicating that more proactive management of vulnerable students, and subsequent engagement by these students with mathematics support provision would reduce failures.

Table 3 gives a breakdown of the number of students attending mathematics support more than once for each module by grade.

Mod.	A*		A		B		C		D		E		F	
	MS	total	MS	Total	MS	Total	MS	Total	MS	Total	MS	Total	MS	Total
a (120)	7	14	4	17	7	26	2	16	2	21	2	12	5	14
b (125)	20	36	3	15	6	22	3	18	3	14	1	11	1	9
c (127)	2	27	1	36	1	32	1	25	1	6	0	0	0	1
d (130)	6	15	5	17	4	31	4	22	8	30	0	5	0	10
e (142)	2	14	6	29	11	32	7	31	7	24	2	5	0	7
Total (644)	37 (35%)	106	19 (17%)	114	29 (20%)	143	17 (15%)	112	21 (22%)	95	5 (15%)	33	6 (15%)	41

Table 3. Attendance at the mathematics support centre by grade. MS = number using mathematics support two or more times.

It has traditionally been accepted that mathematics support has been provided mainly for the benefit of the mathematically less-able students. However from Table 3 it is apparent that a significant number of students use the facility in the pursuit of excellence; 35% of those who achieved an A* sought mathematics support more than once, compared with 22% who achieved a grade D and hence were in danger of failing the module. The comparable figures for the fail grades are: grade E, 5 out of 33 (15%); grade F, 6 out of 41 (15%). The proportions of fail grade students seeking mathematics support is less than those in pass grades seeking mathematics support - this would indicate that fail grade students as well as having ability problems also have attitudinal problems. The data also indicate that the mathematics support services are providing valuable enhancement for the best students.

Conclusions

The mathematics support centre is a widely used facility. In our sample of five first year engineering modules (644 students) approximately 1 in 5 of the students made regular visits to the centre. In itself this is evidence of need, and of student satisfaction with the services offered. Measuring the efficacy of mathematics support work is very difficult but is necessary to sustain funding and to enable focussing of effort where it is most likely to yield positive results. The data in this study suggests that there is a measurable benefit accruing from our activities. There is a small but noteworthy number of students who have made good use of the centre and achieved a minimal pass grade. Given our assumption that attendance can only serve to improve performance, we believe that this demonstrates added value for this particular group and for the university. The retention of but a small number of first year students, who instead of failing and withdrawing remain in the university for three or more years is sufficient to cover the cost of provision. Surprisingly the facility is used more by the better students who are seeking excellence, than by less able student who are looking to avoid failure in the relevant mathematics module. This latter finding suggests that the provision of mathematics support is more wide ranging in its level than traditionally conceived, and that the mathematics support model has moved from one of remedial support to one of enhancement. This is in line with the recommendations in the NAO report (op cit, [10]). The fact that so few fail grade students made use of the centre's facilities is indicative of attitudinal problems. The fact that 28 of the students who failed, but still achieved a Grade E, did not attend more than once is helpful in the development of strategies to target these vulnerable students. For example, we are considering sending reminders midway through the first term to students who have only visited once. These clearly know about the centre and how to find it and perhaps need encouragement to continue to use it. The work described here

indicates one way in which the efficacy of mathematics support can be quantified and is intended to contribute to a wider debate on this very topical subject.

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