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ACADEMIC SUPPORT IN MATHEMATICS

Sylvia Johnson & Susan Elliott
Sheffield Hallam University

Academic support in Mathematics arose from a demand by students and staff for extra help. It has taken two distinct forms. An open access drop in Centre - Maths Help - has been open for 1.5 hours each day of the student term. In addition Susan Elliott has mounted a number of short courses in specific topics at the request of either students or staff. These have lasted anything from half a day to two hours a week for six weeks. This report summarises an evaluation of support activity during the calendar year 1994. It highlights the difficulty of providing targeted support to those most in need, points to a significant lack of confidence amongst even those students following highly mathematical courses, and emphasises the need within the University sector for skilled diagnostic teaching more commonly found in the school sector.

Purpose of the Evaluation.

The aim of the study was to enable the University to examine who used the academic support facility, what they used it for and how better to provide such a facility in the future.
Data was collected from several sources - attendance at Maths Help was monitored during the year, a sample of students was asked to complete a questionnaire at the end of the first year, a further sample of students some of whom had attended Maths Help and some of whom has attended a short course, together with tutors involved in support activity, were interviewed. Short courses were observed. The report draws on data from all theses sources.
During the course of the study the authors sought to set this and future work into an appropriate theoretical context. This led to an overview of a wide range of other research work which is discussed briefly at the end of this paper.

Who used the Maths Help drop-in facility?

The Mathematics Centre is part of the School of Mathematics and Electrical Engineering. Substantial mathematics is also provided in the Schools of Construction, Engineering and Science. A breakdown of Maths Help records by subject area shows the following:

Course area	Number of attendees		
	S1 93/4	S2 93/4	S1 94/5
Maths/Computing	28	41	41
Electrical Eng	73	68	78
Other Engineering	85	66	131
Science	10	5	15
Other (not Ed)	24	18	8
Total	**220**	**198**	**273**

Some individuals visit regularly and the data presented is simply visits made. In fact approximately 20% of first year students in Mathematics and all Engineering areas have attended.

What topics in mathematics did students want help with ?

Topic	S1 93/4	S2 93/4	S1 94/5	%
Basic number	0	4	18	3
Basic algebra	39	24	51	14
Advanced algebra(incl lin alg)	17	13	36	8
Discrete maths topics	8	2	11	3
Functions and graphs	24	5	15	5
Basic calculus	67	43	35	18
Advanced calculus	37	48	78	20
Statistics	12	84	17	14
OR	5	7	0	1.5
Mechanics/statics	4	1	16	3
Use of technology	11	17	34	7.5
Other misc.	9	5	10	3
Total	**233**	**253**	**321**	

This data is not particularly surprising and reflects the concerns expressed by most staff. It is noticeable that since the introduction of the use of graphic calculators and algebraic manipulation packages on a regular basis, the number of requests for help in using the technology has risen.

In an attempt to gain a greater understanding for reasons why students needed help and whether or not they felt more confident by the end of their first year than at the start, we administered a questionnaire to all first year mathematics and electrical engineering students at the end of the academic year 1994. A 50% return was obtained - 37 mathematics students and 64 electrical engineering students.
The next tables show responses to two of the questions they were asked.

Thinking of mathematics.....
Which of the following best describes how you feel when you have to do some mathematics ?

	Maths	Elect	All
Panic stricken	3%	2%	2%
Anxious in case you can't do it	46%	41%	43%
Pleased because you enjoy maths	30%	17%	22%
Indifferent because its something you can do	35%	20%	26%
Challenged but reasonably determined	60%	52%	55%
Frustrated because you don't know how to do it	30%	22%	25%
Frustrated because you don't understand it	19%	17%	18%

The percentage of students expressing pleasure at doing some mathematics is depressingly low, though the percentage feeling challenged but reasonably determined was high.
A relatively high proportion express anxiety even at the end of the first year of mathematically intensive courses. We wonder how this would compare, say, to the anxiety felt about English by English students.

Assess your feelings about each of the following areas using the key :
C - feel confident with
H - could do with more help but know something about
L - can't do at all

D - don't feel I need to know anything about this

	Students responding H or L		
	Maths (37)	**Elect (64)**	**Total (101)**
Fractions	0	14%	9%
Simple Linear Equations	0	17%	11%
More complex equations	8%	20%	16%
Rearranging formulas	8%	36%	26%
Substitution into equn's/formulas	11%	30%	23%
Factorising/expanding brackets	14%	37%	29%
Negative numbers	3%	13%	9%
Use a scientific calculator	0	16%	10%
Use a graphical calculator	46%	31%	37%
Indices	24%	39%	34%
Approximating appropriately	35%	45%	42%
Using percentages	5%	16%	12%

The highest percentages are recorded in calculus, log and exponential functions and complex numbers. The fact that these topics show a high percentage is matched by the high demands for help in these topics at the drop-in help facility.

Of greater surprise to the researchers were the results for indices and approximating appropriately. The researchers have some evidence that students feel that even at a support facility, they do not feel able to admit that they cannot do such " elementary" mathematics.

A further analysis by entry qualification showed that in Electrical Engineering , the previous academic background of students seemed irrelevant to their levels of confidence.In Mathematics, almost all students had an A level pass in mathematics.

Some conclusions from an analysis of all data.

The Maths Help drop in facility appears to offer some students access to immediate help with current mathematical needs. Responses via the questionnaire and the interviews from those who had attended Maths help, indicated largely, that students perceived the help to have been valuable.

Attendance at the drop in facility has varied. A number of factors appear to influence levels of attendance which include :

Clash of timing of the facility with timetabled sessions.
Awareness of the existence of the facility
The nature of the location
Loss of anonymity

Those attending are not necessarily the students with greatest need for additional help in mathematics.This is both positive and negative. There is concern by staff that the facility should not be perceived solely as for those likely to fail maths however, it is clear too that students who need further help are not necessarily seeking it. A number of students have indicated that early on in the first year, they have had too many other concerns and have too wary of admitting their need for help from anyone - lecturer, peers or Maths Help, to take

advantage of the facility early enough. For many students this is about showing yourself up in academic terms.

The time available for individual students within a drop in facility is a crucial factor to both its actual and its perceived success. Some students chose not to attend because it was too busy to get any *real* help.

Subject specific needs brought to the drop in facility are largely in algebra, calculus and statistics.The range of topics over which help was sought in this way was extensive. Staff perception is that the help sought in calculus often masks a need for help with algebra which remains unexpressed in many cases. Given the predominance of requests for help in these three topic areas, it would be appropriate for a resource based drop in facility to concentrate resource in these topic areas.

Whilst most students arrived at maths help with materials of their own, *we* have been largely unsuccessful in encouraging students to go away with material to work at on their own. As such Maths Help has not been a springboard for independent study in areas of weakness. Some students commented on the importance of being able to talk and to discuss their exact problem. They also commented that to go away and work through something when you were unsure of it was a waste of time because you didn't really know which bits to do and which bits not to do.

Staff expertise was needed in two distinct areas. Firstly, the range of mathematical problems presented was very diverse. Any one member of staff found it difficult to have such a range of mathematical topics at her/his finger-tips. Consequently some students had to be sent away with an appointment for a future date to give the staff time to tackle the problem themselves. Some staff were able to effectively help students in areas of mathematics with which they themselves were unfamiliar, through skilled elicitation of the problem and of the related mathematics from the student. This process, it could be argued, actually provided the student with more help than a topic expert might, in that the student had effectively to help herself. However, such skills are high level teaching skills and a considerable amount of staff development is needed to provide a team all highly skilled and confident in such modes of working.

Many students attending the drop in facility expressed a need for help with a broad topic area - "can you explain complex numbers to me". Sometimes this was a request for a superficial understanding - how do you add them, write them, multiply them etc. for which students appeared to be happy with a brief resume. In other cases, students used Maths help as a space and an interaction to help them in understanding what (in this case) complex numbers were all about - an opportunity to gain a meaningful understanding of the topic in question.

The task specific driven nature of many visits and the relatively short time available for help to any individual student seem inevitably to encourage a surface and strategically surface

orientation. This would appear to be particularly true for the "average" student. The more able students who seek help tend to have a clearer idea of the nature of their lack of understanding and the students who struggle most come either with very specific needs - eg language difficulties, or have a high level of motivation to succeed in a subject in which they are completely lost. Such students already have a meaningful orientation to learning and seek support on that basis.
Some overseas students had very language specific needs.

By contrast, Short Courses appeared to offer some students access to help with longer-term mathematical needs.Self- referral, the student's own perception of a need for help , rather than tutor referral appeared to be a prerequisite for a successful short course. Where referral had been tutor initiated, attendance was unpredictable and not always sustained. It would appear that short courses thus offer a successful opportunity for those already motivated and committed to resolving difficulties with maths, but are no more successful than any other method at assisting poorly motivated students.

Short courses were most successful when students themselves control the agenda and hence the content of a short course. Having defined the content, the short course tutor then undertook to cover that content and selected the activities. This handing over of control of the content to the students was in direct contradiction to the majority of the students' experience, certainly in year 1.

Those attending short courses, as for Maths help, were not necessarily the students with the greatest need for additional help in mathematics. It was important that students knew the other members of the group on the short course. The fear of showing oneself up is very great. Students also need to have opportunities to admit that they're having difficulties on a collective basis as well as an individual basis. It's difficult for some of them to admit that there are problems especially if maths is the only subject they are having difficulties with.

The time available was crucial.Short courses take up a relatively high proportion of the 'free' time a student has. Even when such a short course can be conveniently timetabled, there are other problems associated with travelling time, cost of extra travel etc.

Short courses provided a different environment for study. Observers at short courses noted that some students were unused to being asked to work with another student, or to discuss a solution with another student, even to the extent of hiding their work from their partner. In all cases this occurred where (a) the students did not know each other well before the short course or (b) were not self referred.The different environment allowed opportunities to discuss what can be described as "study skills".
Because of this dimension it appeared that short courses **could** act as a springboard to independent study.

For Short Courses, as for Maths Help, there were implications for the skills needed by the

lecturer - expertise is needed in diagnostic teaching, skilled elicitation of the root of the problem and a creative use of the teaching material used.

Theoretical contexts for academic support in mathematics within an FHE context.

There is a body of work on the 'Outcomes of Learning'. This includes measurable outcomes on a global scale : degree classification,drop out rates etc and measurable outcomes on a local scale : Taxonomies of learning eg SOLO . In addition there are statements about the desired/expected outcomes expressed by professional bodies & groups, eg Engineering Council, SEFI, which highlight a conflict between techniques and understanding, between paper and pencil work and the use of technology. It is possible to examine numerical data in terms of the improvement to measurable outcomes which a support activity provides. We feel that this context 'hides' the issues.

Related to work on outcomes is an increasingly large volume of work at HE level which focusses on the 'Experience of Learning'. Studies in this area focus around approaches to learning - deep, surface, strategic, memorising, fragmented... however, in support activity we are frequently dealing with relearning, not learning for the first time.
We feel that most of these global studies are too general - related to main line delivery but not specifically to support.There is some work on individual differences involving individual study orchestration but it is small in quantity to date.

Because we have identified the importance of confidence and individual personal needs in seeking support, it may be that work on anxiety in mathematics, stress, personal agendas, life histories or the specific work on adult learning is an appropriate context for support activity in mathematics. There is, for example, work on general academic support through counselling approaches, Supplemental Instruction (SI) - used extensively in USA, and peer support, though much of this work is a derivation of studying skill support which whilst relevant is limited to the support part of 'support for mathematics'.

The Reflective Practitioner research provides a context for work on short courses . Whilst the drop in facility aims to move in this direction it depends on the motivation of the student to engage in such an approach.

Last, but not least, there is the possibility of setting support work in the area of Cognitive Studies. So for example, help is frequently sought in algebra and there is a vast amount of work on the learning of algebra, mainly with younger children. Here again, we feel we are dealing with students who need to relearn, not learn for the first time.
In a more general context we feel we are working broadly within a social constructivist perspective, but also feel that metacognitive studies may prove useful in further analysis.

We welcome reflections on context !