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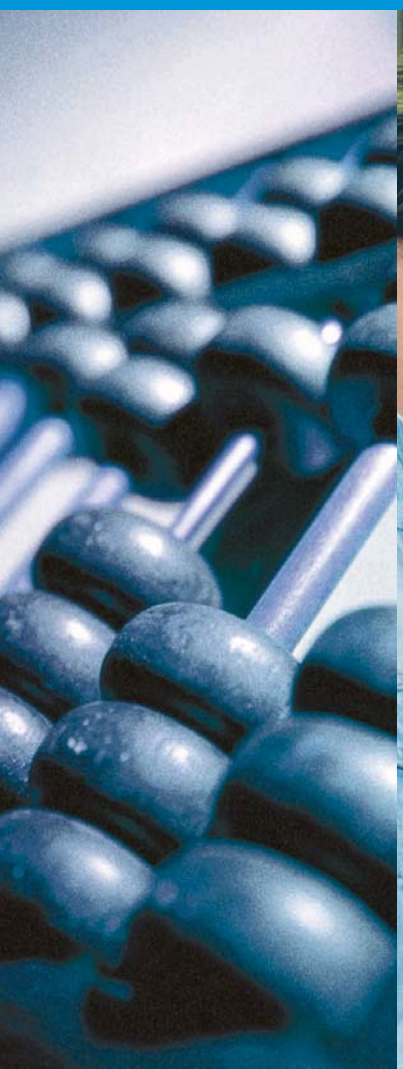
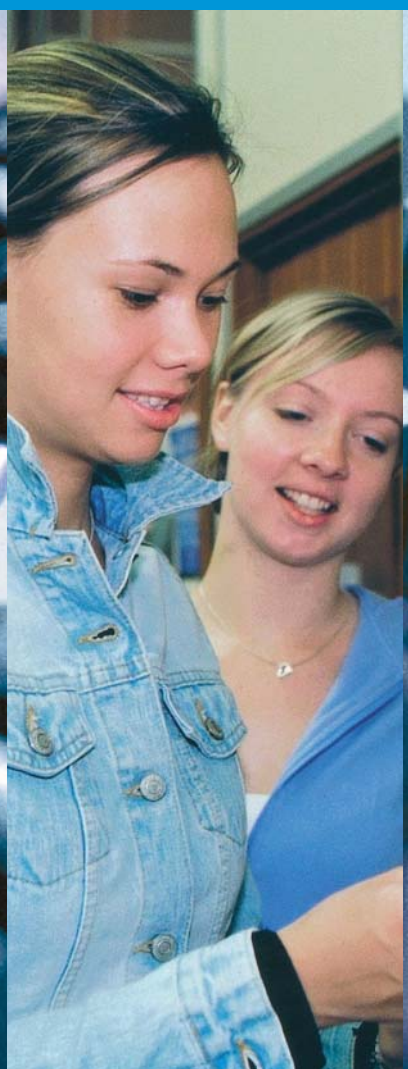
maths support for students





maths support for students

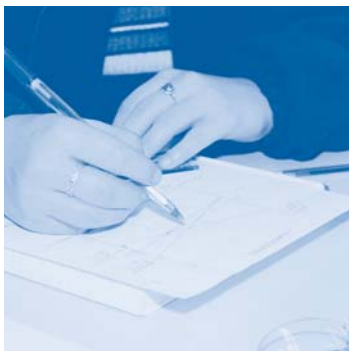
published by the LTSN MathsTEAM Project

www.mathcentre.ac.uk

Contents

Foreword

During the past few years a change has gradually taken place in many of our universities and colleges. There has been a realisation that within all institutions are students who have not had the opportunity to develop fully the mathematical skills required in their courses, and who need additional help over and above that traditionally provided.



Many visionary and dedicated staff have responded positively to these challenges with enthusiasm and resourcefulness, often in poorly resourced environments and always competing for resources against more powerful protagonists. What are evident from the case studies which follow, are the creativity, passion and commitment of those staff involved in mathematics support. There is no doubt that these staff have succeeded in improving the lot of many students in higher education. From pre-sessional courses to summer schools, from paper-based support to interactive web-based e-learning, and from peer support through to fully fledged drop-in centres, this booklet represents a distillation of some of the best practice known to be taking place.

I believe that there is something for everyone in this booklet. Those of you with years of experience will find amongst these pages germs of ideas which you will be able to nurture and adapt in your own institutions. Novices will find plenty of useful suggestions and a wealth of references, together with access to a network of like-minded professionals who will be willing to help.

The LTSN Maths, Stats and OR Network, the LTSN Subject Centres for Engineering and Physical Sciences and the UK Centre for Materials Education, through the MathsTEAM Project are to be congratulated on having the foresight to commission these case studies and put this booklet together. I know that staff in these Centres will be only too willing to assist you should you need further information about any of the activities described in this booklet. They will be delighted to hear about other mould-breaking work which you are prepared to share with our community.

There are still many obstacles to be overcome if students who lack confidence and competence in basic mathematical skills are to be helped towards a worthwhile undergraduate experience. To this end, Maths Support for Students is a valuable contribution. I commend it to you wholeheartedly.

Tony Croft
Mathematics Education Centre, Loughborough University.

LTSN MathsTEAM Project

Funded by the Learning and Teaching Support Network (LTSN), the LTSN MathsTEAM Project (**http://www.ltsn.ac.uk/mathsteam**) has carried out an in-depth survey, examining the following three topics:

- **Maths support programmes and resources,**
- **Current practices for teaching mathematics to engineering and science students,**
- **Diagnostic testing.**

The information has been published in three booklets:

- **Maths Support for Students,**
- **Maths for Engineering and Science,**
- **Diagnostic Testing for Mathematics.**

They each provide a comprehensive collection of case studies, intended to assist you with the challenge of enhancing the basic mathematical skills of engineering or science students.

The contributing authors discuss the execution of current teaching practices based on each of the three topics mentioned above. They talk about the barriers and the enablers in setting up these learning initiatives. For those of you considering the implementation of any of the programmes, each case provides an opportunity to review the learning processes and tools involved. Each booklet contributes to the transfer of knowledge within higher education communities; each case study offers practical suggestions for you to gain a better understanding of the present situation and related topics that merit further exploration and research.

The UK Mathematics Learning Support Centre

During recent years, throughout the higher education community there has developed a growing need to share knowledge and materials, to develop good practice and stop re-inventing the wheel. Funding has recently been made available for the development of the first UK Mathematics Learning Support Centre - mathcentre.

The Centre will use a mix of modern and traditional techniques to allow both students and university professionals free access to samples of high quality learning materials aimed at alleviating the school/university interface problem. It will also use the resource base created by such projects as the LTSN MathsTEAM.

Further information about the mathcentre can be found at **www.mathcentre.ac.uk**.

Maths Support for Students

In June 2000, the Engineering Council (UK) recommended to all universities that those students embarking on mathematics-based degree courses should have a diagnostic test on entry. Moreover, it recommended that "prompt and effective follow-up was essential to deal both with individual weaknesses and those of the whole cohort"

(Engineering Council, 2000)

During the last five years, the implementation of such "follow up" support has increased dramatically. As Engineering and Science Departments face the problem of inadequate mathematical preparation by students, many are setting in place networks of support-based activities. These include:

- Maths Learning Centres,
- Drop-in Centres,
- Summer Schools,
- Computer-Based Support,
- Paper-based support,
- Student Support Websites.

Examples of these initiatives are presented by contributing authors in "Maths Support for Students". Through structured reviews each case study describes the execution of the learning activities, the support needed, the implementation difficulties, evidence of success, and suggestions of how other academics could reproduce the activity. The booklet offers you a chance to explore the growing diversity of support-based initiatives through these examples of good practice found within Higher Education Institutions throughout the UK.

*Reference: "Measuring the Mathematics problem", published by the Engineering Council, June 2000 (see **http://www.engc.org.uk/publications/pdf/mathsreport.pdf**).*

Institutional and Departmental Student Support

Support Offered to Natural Science Students at Cambridge University

Interview with John Leake ▪ Department of Materials Science ▪ University of Cambridge
Interview with Sue Colwell ▪ Department of Chemistry ▪ University of Cambridge

Abstract

Nine years ago members of staff within Physical Sciences at Cambridge University began recognizing that some students were having problems not only with the Mathematics Courses but also with applying material from A level in the context of their scientific subjects. The mathematics workbook was introduced to assist students with revision prior to starting university. On completion the student is asked to fill in a questionnaire that helps to define the problem areas. This is presented to their supervisor. The supervision system is a fundamental feature of Cambridge teaching and one of its main strengths. The student sees a supervisor – most commonly in a group of two undergraduates, sometimes in a group of three and only exceptionally one-on-one – to discuss his or her work for at least an hour once a week. Such support is ongoing and essentially provides individual attention to those students who lack fundamental mathematical skills.

The Execution

The University of Cambridge is a large and complex federal institution where the system of college supervisions is a distinctive feature of the teaching and learning. Supervisory sessions provide highly focused individual support for student centred learning. This vital aspect of student experience complements the formality and routine nature of the lectures. The tutorial aspect of the supervision provides stimulation and a close scrutiny of progress, thus enabling the student to benefit from academic and pastoral support.

The pattern of supervision is composite, being organised across the thirty-one colleges, with the Director of Studies in each College playing a central role. For Physical Science students at St Johns College these supervised sessions take place each week. Each supervisor is responsible for two students; the sessions provide ongoing support, practical examples and guidance. This allows for the development of individual interests and offers student support within the broad framework of the set curriculum.

During the last nine years these supervisory sessions have played a crucial role in dealing with the growing number of entrants who are apparently very well qualified (e.g. three to four “A” grades at “A” level) but lack the ability to understand, or confidence to apply, essential parts of mathematical subjects. Students demonstrated they had not really absorbed what they had been taught. Faced with mathematical analysis in the middle of (say) a lecture in Physical Chemistry or a Problems Sheet in Physics, many students could not recall the necessary mathematical methods.

In dealing with this situation, approximately nine years ago the Faculty of Mathematics introduced the mathematics workbook. The workbook is intended for students coming to Cambridge to study the physical science options of the Natural Sciences Tripos.

In the first year of the Natural Sciences Tripos, there are three distinct mathematics courses: Mathematics (courses A or B), Quantitative Biology and Elementary Mathematics for Biologists. The mathematics workbook is posted out prior to the beginning of the university year, to all those entrants intending to take Mathematics (courses A or B). For those who have taken a “single” mathematics A level, it involves some material which is explicitly covered in the first year. It provides a useful set of revision problems for those students who have already mastered almost all of the material during a “double mathematics” A level course. If presented with anything new the student is referred to the textbook, Mathematics – The Core Syllabus for A Level by L. Bostock and S. Chandler, published by Stanley Thornes.

Attached to the back of the mathematics workbook there is a questionnaire, asking the student to indicate which questions they had difficulties in answering. This information is sent back to the lecturers. The supervisors also review this information and during the first session they go through the questions which the students could not understand. This gives an indication of the “problem areas” and they can be dealt with during future sessions.

The mathematics workbook is very much focused on the problems at the interface between school and university. Once the student has entered the Cambridge teaching system, student support in dealing with the maths problem is based on working independently and engaging in discussions with the staff.

What Support Was Needed?

Basically through the supervisory sessions, support is ongoing. As problems arise supervisors can deal with them. The supervision is extremely flexible. There are worked examples handed out, which are gone over during the sessions. The questions are carefully designed, some taken from past exam papers. The university provides courses in supervising for members of staff as well as post-doctoral research assistants and graduate students in appropriate disciplines.

The Barriers

In the first year of the Natural Sciences course students have to take four more-or-less equally weighted subjects, of which a mathematical subject is one. Their timetable is therefore very heavily loaded and it is difficult for them to find time to fit in additional work.

The Enablers

Academics that are teaching in later years of various Natural Science subjects are very dependent on the first year maths course being successful. Students are strongly encouraged to get on top of their maths in the first year using the supervisory sessions. The colleges are all different institutions and they are small enough to react to such a problem as the growing deficiency in basic mathematical skills.

How Can Other Academics Reproduce This?

The Mathematics Workbook was introduced during the period when the University was starting to realize that students were having problems not only with the Maths Courses but also with applying the things they should be familiar with from “A” level in the context of their scientific subjects. St Johns College appointed a Teaching Fellow because the Teaching Fellows in Natural Sciences were concerned about the results of the first year maths exams in the immediately preceding years. In 1993, the Workbook was introduced as an “initial diagnostic tool”. It is a formal exercise designed for incoming students. Those interested in the workbook should email: **faculty@maths.cam.ac.uk**

The supervisory system is taken very seriously; it is an intense hour and provides valuable support for the students. It is built into the already existing teaching system at Cambridge and other institutions wishing to implement the system need to be aware that it is very resource-intensive.

Quality Assurance

The supervisors write an assessment report at the end of each term and the students write a self-assessment report of their own progress as well as on their supervisors. The precise handling of the self-assessment reports varies from Director to Director.

In St Johns College, the Director of Studies system involves someone at the top of the pyramid, who is the overall Director of Studies in Natural Sciences and then there are Directors of Studies in each of the subjects within Natural Sciences. Their job is to line up the undergraduates with their supervisors and to monitor the performance of students and supervisors. In many instances the Director of Studies will also be a supervisor in that subject. Meetings with the overall Director of Studies and the Subject Directors precede the start of supervisions. In addition to Directors of Studies, each undergraduate has a (pastoral) Tutor who receives copies of all the supervisors' reports and discusses them with each student on a one-to-one basis as part of a review of that student's overall progress and development.

Student Support Based on the Three Stream System at UMIST

Interview with Colin Steele ▪ Director of Service Teaching ▪ UMIST
Interview with Alasdair Renfrew ▪ Department of Electrical Engineering and Electronics ▪ UMIST

Abstract

UMIST introduced a three level course structure to help students entering civil engineering, chemical engineering, electrical engineering, chemistry, mechanical engineering, computing and optometry to cope with the maths content of each of the courses. Based on previous qualifications and a diagnostic test, students are allocated places within the P, Q and R stream.

The Execution

Between 1993 and 1996, it was identified that students entering various disciplines at UMIST, e.g. civil engineering and electrical engineering, were not coping with the maths courses because of a lack of basic mathematical skills. This was affecting overall curricula and many students were dropping out or failing.

The mathematics department introduced extra classes to support the students. They were encouraged to attend these classes which were regarded as a “friendly resource”. In the end, they did not provide adequate support, as the classes were not included within the formal assessment procedure.

A new scheme was introduced, based on a three level course structure. This divided entrants into three levels, ranging from the weaker students, average students and those who are capable of doing more advanced course work. The titles for each of the three levels “high”, “medium” and “low”, were later renamed; the P, Q and R stream. The most important aspects of this scheme are that weaker students are provided with extra assistance but they are forced to work for marks; average students could progress separately from those who needed extra support; and advanced students are able to learn more.

Each stream includes entrants from various disciplines, i.e. civil engineering, chemical engineering, electrical engineering, chemistry, mechanical engineering, computing and optometry. The student allocation into the streams is based on a short forty-minute diagnostic test. Students are assessed on six sections; arithmetic, algebra, trigonometry and co-ordinates, log and exponentials, basic differentiation and basic integration. The distribution of the students within the streams is based on previous mathematical qualifications and the marks from the diagnostic test. (See details on page 36).

The actual allocation process is carried out “fairly algorithmically” although those near the borderline require careful consideration. The streams P and Q are easily identified although a number of students who have a “C” or “B” grade at A level performed below this standard in the diagnostic test. These students are placed in the Q stream for the first few weeks; in week four they sit another test in which their marks will generally improve. If their performance remains poor the students will discuss their results with the Director of Service Teaching. These students are then moved either to the R stream or remain on the Q stream with a clear indication of the further work which is required.

For students on the P & Q streams most of the coursework is done through homework assignments, two or three per term. The R stream has regular tests every couple of weeks. If the students perform poorly on a test, they can re-sit in the intervening week; they are constantly being examined.

The number of streams used by the different disciplines varies. For some, all the students from that course are allocated to one stream, as this is more appropriate for the degree course. A more mathematical subject such as electrical engineering is divided over the three streams; P, Q and R. The results from the diagnostic test are available to all the disciplines. This provides departments such as mechanical engineering, which only use the Q stream, an indication as to which students may have difficulties.

At the same time that the students are streamed into the courses they are also divided into several tutorial groups. There is a single tutorial group per department for the P stream. The Q and R streams are each divided into three tutorial groups per department. There are eight students per tutorial group in the R stream and between twenty and thirty in the Q stream. A tutor is assigned to meet once a week with the tutorial group and to be available at other times. Regular attendance at these tutorials is highly recommended and non-attendees are tracked down. The tutors are members of the mathematics department, either members of staff or post-graduate students.

Support is also provided through the personal tutorial system within the various departments. All first year students are allocated a personal tutor within three days of arriving at UMIST. There is a compulsory one hour meeting once a week, which provides a regular point of contact. The personal tutor’s role is partly academic and partly pastoral. Attendance is recorded and those who do not participate in the scheme are chased up. Course work is handed back through the tutorials and questions can be discussed with the personal tutor.

What Support Was Needed?

The role of the Director of Service Teaching is crucial to the success of the three course level scheme. This provides a single point of contact within the Mathematics Department for all students and academics. The constant collaboration between the Director of Service Teaching and the Director of Studies in each relevant department has established a valuable network which is used to manage the streams and the requirements of those involved. The three level course structure involves lecturers, tutors and postgraduates from the Maths Department and personal tutors from each of the departments. The Teaching and Learning Support Centre runs training sessions for the postgraduates in which the Director of Service Teaching plays an important role.

The Barriers

The allocation procedure has been refined as there was too much emphasis on the diagnostic test and not enough on the student's previous results. The result is that fewer students are changing their courses. Several departments took time to decide the policy for assessing and combining the results to give the final year mark. For example, how do you compare a student who has 60% on the Q stream with a student who has 60% on the R stream? When it comes to getting the final mark for the year do you count them as equal or do you give a boost to the Q stream student or a penalty to the R stream student? Most departments decided to judge the students relative to the course they have completed.

Evidence of Success

At the end of each semester for the P, Q and R modules, students are required to fill in a questionnaire. The two main questions are the rating of the lecturer and the rating of the course on a scale of one to five; students can also include comments. Results on average have been between about 3.5 and 4.5.

How Can Other Academics Reproduce This?

- This program is for non-maths students.
- The program requires an active co-ordinator.
- The co-ordinator must operate from within the Maths Department.
- The co-ordinator must actively work with the other departments to develop a collaborative network.
- The network is used to help the co-ordinator establish the three level course structure and the integrated tutorial system for the various departments.
- The other departments must be willing to interact and exchange comments.
- The institution must be willing to provide funding to employ staff to run the scheme and to pay postgraduate tutors.
- The structure in place at UMIST the first academic year after being suggested; the method of assigning students to the relevant streams is being refined constantly.

Quality Assurance

For the Quality Assurance Agency (QAA) visit, the three level course structure was assessed multiple times through each of the various departments and this will continue within the new auditing establishment.

Student Support and the Bridging Course at University College London

Interview with Robert Bowles ▪ Department of Mathematics ▪ University College London
Interview with Keith Ball ▪ Department of Mathematics ▪ University College London

Abstract

University College London has established a wide selection of teaching resources to support a dramatic increase in the number of entrants to the Mathematics Department. This includes a diagnostic test for all entrants, a workbook for students to complete before the first semester and an integrated system of tutorials, lectures and a problem class. An intense Bridging Course also provides students with a valuable and comprehensive perspective of university mathematics.

The Execution

During the early to mid nineties the Maths Department at University College London was faced with losing its auxiliary teaching. It was proposed that disciplines such as engineering would teach maths to their own students.

The impact of this proposal on the Maths Department was not as serious as first thought; some courses were removed, engineering in fact remained and new degree courses were started. Yet, in considering the future effects, the Maths Department decided to raise the entry standards and to take on more students. The entry requirements initially were two B's and a C; this was gradually raised to two A's and a B and many students have three A's. The effect on the intake of first year students was evident as the numbers increased between 1992 to 1994 from 40 to 120. Over recent years, the entrant numbers have increased to 140.

Extra support was set in place to maintain the standard and cope with the growing number of first year students. This includes the following:

- Peer Assisted Learning was established through the Higher Education Research and Development Unit, which is now a separate department in UCL, the Department of Education and Professional Development.
- The teaching practice within the problem class changed. Originally there were three lectures and one problem class a week; the students were given a problem sheet and no answers. During the problem class, essentially a member of staff went over the answers on the board. This practice was stopped and the answers were given out. The hour was then available for a member of staff and one or two postgraduates who do the marking, to answer questions on the work. During the problem class, which is not compulsory, the work is given out and handed in. The class is held in a big room and the students are encouraged to work together to solve the problems.
- The tutorial system, which is separate from the problem class, remains a crucial part of the support structure. There are four tutorials a week, one for each maths course. The lecture schedule for first year students consists of calculus, applied maths (standard maths and probability), algebra and analysis. Student numbers per tutorial are around six; they have an hour with the tutor to talk about the notes and/or the problem sheet. They are compulsory in that if the students miss too many they are chased up; if however they miss one they will not fail the course. The tutorials are not offered to other departments.
- A diagnostic test is given to all maths students on arrival; the marks go to the tutors. There are no remedial or top-up classes for those who fail the test.
- The Calculus Course has proven difficult for many first year students. The people who come with just a single maths A level find it very hard. To assist, a workbook is sent out to all entrants to the course, before the beginning of the first semester. Each student is required to complete all the questions. If at the beginning of the university year they are unable to do the work, students can attend extra lectures. For the first five weeks of the calculus course, an extra lecture is available at 5:00pm on every Monday. The workbook is available on an intranet.
- The Bridging Course started in 1997. The original motivation was to deal with not so much the decrease in knowledge, rather that students no longer have the experience of thinking things through for themselves. The course is offered to assist students to fill the gaps and prepare them for the way teaching is carried out at the university. Most students expect a revision course but this is not the case. Many find it extremely difficult; it is the first time they have really had to work. There is no condition of entry; internal students pay £65, and external students £85. The intake is between 70 to 80 students per course.

Each day is devoted to a particular topic; there are two lectures on that topic in the morning and then the students work on problems in groups in the afternoon. Lecturers and graduates are available to help the students, as in many cases they find the problem sessions difficult. The aim of the lectures is not so much to prepare for the afternoon problems as to present the A level work in a different way. The students learn to experiment and they soon realize that they are not going to be able to answer every question. The course presents a "mature" view of mathematics and how everything is related; there are no recipes, there are only tools. There is a test at the beginning and at the end of the course; the mark is not forwarded to the tutors.

What Support Was Needed?

- There is no official co-ordinator.
- The Bridging Course is run separately from the lecture programme.
- Postgraduate students mark the problem sheets and help in the problem class.
- Six postgraduate students are selected to assist on the Bridging Course.
- Mathematica is available.
- Some lecture notes are also available on the web.

The Barriers

- Integrated within the course system so there are no actual overall barriers.
- Finding staff time to teach and participate in the support schemes.

The Enablers

Changed the name of the course from Top-Up to Bridging Course and the number of applications increased.

How Can Other Academics Reproduce This?

- Establish a tutorial system.
- Dedicated staff.
- Bridging Course is funded by the students and topped up by the university.
- An enthusiastic tutor to run the Bridging Course.
- Peer Assisted Learning (PAL) requires expertise and funding.

Quality Assurance

There is standard Quality Assurance for the courses and the PAL Sessions.

Maths Support and Drop-In Centres

The Provision of Maths Learning Support at De Montfort University, Leicester

Frances Wright ▪ Study Learning Advisory Services ▪ De Montfort University ▪ Leicester

Abstract

The Maths Learning Centre (MLC) was first established as a library service in 1994 but initially struggled for funding and recognition at a wider University level. Since 2000 it has been incorporated into the centrally funded Student Learning Advisory Service (SLAS).

The Execution

The Maths Learning Center (MLC) is part of Student Learning Advisory Services (SLAS) which was formed in May 2000. SLAS brought providers of learning support within the University together to form a team which provides direct specialist learning support to students and professional development for academic and support staff. Prior to its incorporation into SLAS the MLC had been a library service which was set up as part of a wider library based learning support service in 1995.

What Support Was Needed?

MLC staff believe that students need to learn maths in context but no one person can understand the context in which every student in the university is learning maths. Our staffing level is now slightly more than one full time post but it is shared between 4 people; one from engineering, one from the maths department with a statistics background and two generalists with FE / adult education backgrounds. We try to direct students from different faculties to the person who is most likely to be able to help them but we also support and educate each other.

The focus of the MLC is clearly a student's maths learning needs. However we feel that wider learning support issues, ranging from encouraging the development of an organised approach to study to dealing with the emotional factors involved with maths learning, are very important in helping students achieve their own maths learning goals.

All staff are experienced teachers who have developed, through formal study or reflective practice, an appreciation of the complexity of student support but this is an area in which staff development is also needed. The placement of the MLC within SLAS facilitates the development of this aspect of our work.

Within the SLAS team there is a wide range of professional expertise in learning support. As a result the MLC finds itself in an environment in which the full range of learning support issues are discussed. Such discussions help to broaden the understanding of the staff who take part in them. As a department we have also organised joint staff development sessions with other sections of Student Welfare, such as counselling, which have been very helpful in enhancing our ability to understand the wider aspects of student support.

The Barriers

Since 1998 the MLC has had one permanent half time post and a number of part time hours. Because of the way in which the university sets its budgets the Centre never knows from one year to the next how many hours it will have in the following year, so forward planning is very difficult.

The hourly paid staff mainly work at the lunchtime drop-in sessions. Students come to the drop-in of their own accord, sometimes as a result of staff recommendation. According to the feedback we collect they are appreciated by the students who use them. However we don't see this as the only way to deal with the diversity in maths background and learning needs that the student body brings to their modules. We have had some success working directly with colleagues, but hourly paid staff do not enable the MLC to offer the time-tabling flexibility needed to promote this kind of work as much as we would like.

The Enablers

The key to success in working with colleagues is 'working together'. We believe that you can't teach maths to someone who does not want to, or does not perceive the need to, learn. So our starting point is the students' perception of their own learning needs. We also believe students need to learn maths in context so we need colleagues to provide us with the context.

We have run a number of pilots for direct support programmes. From this experience we are developing a model of 'best practice'.

Stage 1

Following a request from a department for the MLC to work with their students the first stage is the writing of a self assessment exercise which contains maths questions set in the context of the subject, provided by colleagues, and more abstract questions which we write.

If possible and if appropriate we try to emphasise the applied nature of the maths the student now needs to learn by including a question for which the 'correct' answer may not be the one which accurate calculation alone will give. Judgement related to the subject is also necessary.

The exercise is given to all the students in a group. This may happen during induction, in a tutorial session, at the start of a lecture; the timing is the choice of the department concerned. Students are asked to:

- read the question.
- consider how confident they feel about being able to answer it.
- try to work out the answer .

They are then shown the answers with suggested methods (the opportunity is taken to show them that there is often more than one way of arriving at the correct answer) and asked to:

- mark their own work.
- re-assess their confidence level.

Stage 2

The second stage is the production of subject specific materials to teach with. We ask colleagues to provide subject specific questions and incorporate them into our generic teaching materials. With a reasonable knowledge of MSWord this is not too difficult. It is very important that colleagues provide questions because;

- They enable us to gauge the level they want their students to work at.
- It is clear from feedback that the students respond well to subject specific questions.
- It encourages colleagues to become involved.

Stage 3

Following the self assessment but as part of the same session students are informed that there will be a short (anything from 3 to 12) series of weekly maths classes and they are told what topics will be covered – or if the group is small and the situation sufficiently informal they are asked what topics they would like to cover.

Attendance is voluntary. Getting students to attend and work seems to depend more than anything else on how well organised things are. Ideally everything is planned well in advance; the time slot for these classes appear on student timetables, hourly paid staff can be asked to teach them and the materials used are well thought out.

Stage 4

The fourth stage is the collection of feedback from students and department staff and the dissemination of student feedback to colleagues.

Evidence of Success

- Every student who attends the drop-in is asked to 'sign the attendance book' and comment, briefly, on the support received.
- Feedback is collected from all class taught groups.
- We receive anecdotal evidence of the success of our work from students who return to thank us but we are starting to track students we support in a more formal way.

How Can Other Academics Reproduce This?

The institution has to be convinced that it should provide centralised learning support and that maths learning support should be part of this provision. Arguments that might be used are well documented in other places. Our experience suggests that the following are important:

- The provision of a well-organised, visible and accessible student support service is likely to attract students with diverse learning needs. It helps the university to enable students not only to progress through their degrees but also to develop skills that contribute to career enhancement.
- The integration of specialists from a number of areas of learning support provides economy of scale:
  - Support can be provided all year round, not only in relation to taught courses.
  - The support is provided by specialists in specific areas of student support.
  - The service can play a role in staff development.

Quality Assurance

The MLC's line management structure is through the SLAS department manager who is a member of the senior management team which reports to the Pro-Vice Chancellor responsible for The Student Experience. This structure enables the MLC's voice to be heard at higher levels in the university structure and in turn enables the university to monitor the activities of the Centre.

Reference

Maths Learning Centre;
http://www.library.dmu.ac.uk/About/MLC/; (13-09-02).

The Mathematics Learning Support Centre at Loughborough University

Tony Croft ▪ Maths Learning Support Centre ▪ Loughborough University

Abstract

The Centre was established in 1996 within the Department of Mathematical Sciences in order to underpin the Department's service teaching commitment to engineering undergraduates. In the first instance funding had been made available through an internal university learning and teaching initiative for a period of two years. Because of its early successes the Centre became a permanent feature in 1998 and now serves any student in the university who might benefit from additional resources, over and above those normally provided, to help them in their learning of basic mathematical techniques.

The Execution

In 1996 forward-looking members of the Department of Mathematical Sciences secured funding from an internal university learning and teaching initiative sufficient to open a Mathematics Learning Support Centre. The main reasons for doing this were to underpin the substantial service teaching commitment of the Department to engineers, and to recognise a deteriorating situation regarding preparedness of many of these students for the mathematical demands of their programmes. A full-time manager was appointed with the task of developing the Centre, initially for the period of two years. Prior to the appointment of the Manager, space was made available within the Department sufficient to accommodate the Centre itself and an office for the Manager.

In October 1996 the Centre opened, drop-in surgeries were started from the third week of the autumn term, and a vigorous programme of advertising was undertaken to raise awareness amongst first year engineering students. At the same time supporting materials were either purchased or developed in-house. These included supporting computer packages such as Transmath, Mathwise, various GCSE and A level items of software, videos etc.

Almost immediately the Centre had a positive effect on the student experience. It also became apparent that many of the resources available to support engineering students were also highly relevant to the physical sciences, mathematics, business and economics. Before the end of the initial two-year period a decision was made in the University to establish the Centre on a more permanent basis and to fund its management by top-slicing all three faculties in the university according to student usage. This formula has remained in place since then.

A wide range of supporting mechanisms are available. Drop-in surgeries are staffed either by the Manager or by other members of staff from the Department of Mathematical Sciences. Leaflets are available covering a very wide range of topics.

A variety of pre-sessional materials have been developed. For example, An Algebra Refresher is a booklet which is sent out to all honours and joint honours mathematics students during the summer vacation. Recently the booklet has also been sent to some groups of engineers, and physicists.

What Support Was Needed?

The Centre, since its inception, has been managed by an experienced university teacher, who has prior first-hand experience of the difficulties non-specialist students face in getting to grips with the mathematical demands of their courses. No staff training was available in the early days; with hindsight this has been a weakness and is one which is being addressed in part now. Consideration is now being given to offering staff development sessions for academic staff in other departments to help them to introduce supporting measures within their own teaching.

The Barriers

One of the barriers has been a reluctance on the part of many students to seriously engage in a program of remedying deficiencies in their prior knowledge, even when these are pointed out through diagnostic tests or poorly-graded coursework. Internal pressures on staff to engage in research activity rather than devote time to learning and teaching developments has meant that it is difficult to change patterns of teaching to cope with the more diverse student entry.

The Loughborough Centre was well-endowed in the first instance because the initial grant was sufficient to provide, amongst other things, a number of computers and software. However there was no recurrent grant other than a token amount to cover day-to-day expenses such as printing costs. Consequently, it has been impossible to plan a hardware renewal or maintenance strategy.

The Enablers

A great deal of work was done, especially in the early days, to promote the Centre around the university and through all of its support mechanisms, e.g. the counselling service, the university's study skills unit. The university's undergraduate prospectus has a piece on the Centre and includes a photograph. Together these have resulted in a relatively high level of awareness amongst the student body in general and amongst engineers and mathematicians especially. In addition packs of information were provided to admissions tutors for use during the induction process.

Evidence of Success

An important source of evidence is usage statistics. In addition to knowing the total number of students who have visited the Centre for help it is useful to distinguish between different programmes and different departments from which students have come. At the Loughborough Centre 'Comment Cards' are available which students can complete and deposit in a box in the Centre. Another source of evidence of success is the External Subject Review (or Teaching Quality Assessment). This is particularly valuable in that it is external. During the past few years a number of these have taken place and students have reported to assessors on the quality of service that they have received from the Centre.

How Can Other Academics Reproduce This?

Establishment of a Centre is not a trivial task and requires a major commitment from the university. It will require the determination of a staff member to raise awareness of the need in his/her department and to convince the relevant authorities of the benefits of such a Centre. A sympathetic Head of Department will be able to move things forward. On occasions sources of funding do become available for learning and teaching initiatives and it is important to look out for these. It is important to build up a network of allies who will support applications for funding in this area – for example colleagues in engineering or the Business School who are aware of the mathematics problem, colleagues in Study Skills Units and other support units. If significant sources of funding are not available, a keen member of staff could start a low-key operation, especially now that the LTSN Math, Stats and OR Network is making a range of resources available to facilitate this.

Quality Assurance

The Centre at Loughborough has a management committee which now meets once a year. In the early days it met more frequently and helped to guide the manager. It can act as a conduit through which information can be passed to other parts of the university. One of the frustrating experiences of running a Centre has been that, by and large, the Centre has tried to respond to a problem, rather than be able to influence in a significant way what is taught and how it is taught.

Other Recommendations

The main recommendations would be, that if a Centre is to exist at all;

- Ensure that adequate administrative and technical help is in place, and sufficient funding is available to enable an on-going staff development programme.
- Be very clear about which students in the university are entitled to use its facilities.
- Be very clear about the sorts of questions you will deal with and which you will not.
- Be clear about boundaries. For example, we have recently offered a special service to students who are registered as dyslexic. The English Language Study Unit do likewise. We have had to be very clear about what the tutor can and cannot do, for example she has been told not to receive or comment upon assessed coursework attempts and this is made clear to students during their first visit.
- It is strongly recommended that a number of staff are involved in a serious way so that the load is shared, and there can be a common purpose.
- It is essential that adequate administrative and technical support is available.
- It should be made clear to the university authorities that a support centre alone cannot solve the very many deep-rooted problems caused by an inadequate mathematics education system.

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The Study Support Centre, The Robert Gordon University, Aberdeen

Donna Ellis ▪ Study Support Centre ▪ The Robert Gordon University

Abstract

The Study Support Centre (SSC), within the Robert Gordon University (RGU), aims to provide students with assistance in Mathematics, Writing & Communication skills, Information & Communication Technology applications, Statistics, Study Skills and support for dyslexic students. The SSC offers students independent assistance through individual and small group tuition outwith their normal programme of study, as well as Computer Assisted Learning (CAL) packages, specialist software for special needs students and text based self-learning materials. The SSC has created a basic mathematics diagnostic assessment, which we give to first year students in many Schools. Currently, in collaboration with the School of Engineering, an engineering principles diagnostic assessment is being designed and implemented.

The Execution

There is an increased need to support students throughout their Higher Education, because of the trend towards wider participation and employers' increasing demand for vocationally apt students. Due to these trends and life long learning, students now enter the system with more varied qualifications and experiences, hence the need for support.

Within the former Faculty of Science and Technology at the Robert Gordon University (RGU) it was identified that a support mechanism was needed for their students at risk of dropping out or failing due to poor knowledge of mathematics. As a result the Mathematics Learning Support Centre (MLSC) was founded back in May 1996. Within two years, students displayed and lecturers highlighted concerns of weaknesses in other areas. In October 1998 the MLSC became the Student Learning Support Facility (SLSF), expanded in size, subject base and student base offering support to the entire University. In 2001 the department changed its name again to The Study Support Centre (SSC) because of the stigma that is associated with 'Learning Support'. At present support is provided in terms of assistance with Writing and Communication Skills, Information & Communication Technology applications, Study Skills techniques as well as with Mathematics and Statistics, plus support is provided for dyslexic students. The SSC tutors are available at three campuses, where students can either drop in to use the Centre's facilities or arrange an appointment.

The SSC offers students independent assistance outwith their normal programme of study. The Centre uses a holistic approach to its support by informally assessing a student's individual needs and attempts to adopt a teaching/learning style that suits that student.

The Centre has a friendly informal environment, which is open for use by the students in a variety of ways. Students can gain support through a variety of methods:

- Individual tuition
- Workshop
- Group tuition
- CAL software
- Diagnostic Assessments
- Video Assisted Learning (VAL) material
- Text-based material (worksheets & textbooks)

Students mainly request personal or small group tuition and access to our study area and computers, which provides a quiet place for students to work with the advantage of a tutor being available at most times.

The SSC has created a basic mathematics diagnostic assessment, which we give to first year students in many Schools at the commencement of their course. Currently, in collaboration with the School of Engineering, we are designing and implementing an engineering principles diagnostic assessment. Both assessments are delivered over the network. Results are fed back to students, their personal tutors and lecturing staff. These reports indicate students' strengths and more importantly, weaknesses needing addressing at a very early stage. Furthermore it allows course tutors and the SSC to make appropriate provisions.

Students are informed about the SSC during induction days along with email messages, plasma board displays and projected presentations (which are displayed throughout the year). Students can either drop in to the Centre or make an appointment. We advise the students to arrange an appointment to ensure that there is a tutor or the facilities are available. Tutors can refer students. Attendance is on a voluntary basis; therefore even if a student is referred they may decide not to obtain any help. As normal, the students who desperately need the help tend not to appear and generally disappear out of the system.

What Support Was Needed?

Fortunately the staff at the Centre have had experience of the content of courses and the common difficulties students encounter. However collaborative support is required from the lecturing staff, especially if they refer students, to inform the Centre's staff of the needs of students with respect to their course materials and any special requirements. Furthermore, University staff should be informed of the function, the facilities available and what can be expected of such a Centre.

The Barriers

Ensuring that staff and students are aware that RGU has a department dedicated to supporting students throughout their studies can be difficult. It is apparent that the Centre has not been fully integrated into the learning ethos of the University. A large variety of publicity mechanisms are used to advertise the SSC from posters to presentations and emails.

It is considered that the SSC teaches 'thinking' skills. There is a learning culture barrier, especially amongst students who have recently finished their Secondary Education, who have inappropriate academic, craft and thinking skills.

The Enablers

Word of mouth has been the Centre's most successful promotion mechanism. Generally, if a student visits the Centre, more often than not, they will return and usually with more students in tow or a student will visit because a peer has recommended it. A great amount of effort is put into promoting the Centre to both students and staff. It is beneficial to create good links with other support mechanisms (both internal and external) and to establish a good rapport with both students and staff.

Many difficulties are not just specific to an individual subject such as mathematics. The Centre expanded its subject base, adopting a holistic approach to its support. The Centre has helped students to identify the areas in their study where they have difficulties and provides guidance on how to overcome them and become more effective students.

Evidence of Success

Both students and staff praise the Centre on its efforts in assisting them to improve the University experience of the students. Positive feedback has been received in the Centre's evaluation forms. Students have been known to further comment about the value of the Centre in Course evaluation forms and during external assessment procedures.

Students comment that the Centre "is the place to come and ask your stupid questions and get a proper answer, rather than asking your lecturers and getting the 'well really you should know that'. Brilliant"; and that at later stages they no longer need to visit the Centre because we have improved their basic skills, enabling them to study effectively and independently. Lecturers value the Centre's facilities since they spend less time dealing with students' basic maths difficulties. Details of students who use the SSC are logged and tracked. Analyses have been conducted comparing students who have used the Centre or not and students who entered the University through an Access course or not.

How Can Other Academics Reproduce This?

To establish a Centre many factors have to be considered and implemented.

- Determine the requirements for a Centre. Involve a broad cohort of team members from across the University to ensure the Centre meets the needs of the range of students and its focus/influences do not become too narrow. The SSC makes use of a steering group for overall views and ideas and a management group when making detailed decisions.
- The location(s) of a Centre should be easily accessible by all students.
- Setting up a Centre will require the recruitment of staff (tutoring staff all had teaching experience/qualifications), and procurement of office equipment, teaching/learning equipment and materials.
- Ensure the entire population of the University is aware of the Centre and its functions.
- Use a variety of methods and mediums to recruit students.
- Determine how the Centre will be funded and sustained. At the Robert Gordon University, the University funds the SSC.

Quality Assurance

Annual reports are produced which state the progress and developments of the Centre. Targets are set at the beginning of each year based upon the figures and achievements of the previous session. These include setting goals for the number of students we help and hours spent assisting students. Student numbers and tutoring hours are closely monitored for each tutor, subject and teaching/learning/support method.

Other Recommendations

- Maintain an environment conducive to learning. The SSC has a friendly and inviting atmosphere, enabling students to be at ease so that they feel that no matter how trivial or complex their problem is that it is important and even if staff cannot help they will provide guidance on where to go for support.
- Endeavour to make students more independent and responsible for their own learning.
- The performance of the Centre should be regularly reviewed with its strengths and factors of weakness being identified.
- Teaching and learning techniques need to be kept up-to-date.
- Feedback from both students and staff should be considered and acted upon where necessary.

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Open Learning Resource Centre at the University of Huddersfield

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Abstract

The Open Learning Resource Centre (OLRC) at the School of Computing and Mathematics, University of Huddersfield provides a quiet environment with seated study places for up to sixty students. The Centre originally operated from 8.30am to 4.30pm every day but that has now been extended to cater for the needs of part-time students. Every day a tutor provides a surgery on a one-to-one basis to answer questions posed in mathematics, statistics or operational research (MSOR). It was also commended by the QAA Visiting Panel during a recent Teaching Quality Assessment.

The Execution

In 1987 the Dean of the School of Computing and Mathematics set aside a small tutorial room and equipped it with shelving to house books and other teaching materials. In addition a small number of tables and chairs to seat up to eight students were installed along with a desk and office area for a part-time technician. The Dean christened it the Open Learning Resource Centre (OLRC) and its purpose was to provide the School's students with a focal point to which they could bring their academic problems. The room was quite small and for some time the Centre was seen as a curiosity and was not particularly well or regularly used. When we started to provide one-to-one tutorial assistance. It soon became apparent that the students appreciated the service offered. As time progressed and the students became more aware of the facilities available, the part-time technician became full-time and the room was moved to a larger space. The room then became a focal point for staff as well as students and eventually, with further expansion the Centre could accommodate 20 students for private study. Also, one half of the room had been partitioned off to provide space for ad hoc tutorials especially for those students who needed extra help with their mathematics and who could be persuaded that additional tutorial assistance would be of benefit to them. The Centre also received a grant from the University to install six computers, each equipped with its own video disc.

In 1992, the School moved to its current premises, a large converted woollen mill, and the OLRC was provided with a much larger space which it shared with the new Teaching and Learning Resource Centre (TLRC) overseen and operated by a full-time secretary. The latter was installed in response to staff interaction in the OLRC and aims to provide information and assistance to the staff of the School to aid in their pedagogy. The OLRC now provides a quiet, welcoming environment with seated study places for up to 60 students. The Centre originally operated from 8:30am to 4:30pm every day but that has now been extended to 6:30pm on Mondays, Tuesdays and Wednesdays to cater for the needs of part-time students. Every day from 1:15 to 2:15 (12:15 to 2:15 on Tuesday) a tutor provides a surgery on a one-to-one basis to answer questions posed in mathematics, statistics or operational research (MSOR). The Centre is designated solely as a student resource and is not used for formal teaching or group tutorials. To support these activities a number of in-house documents are available dealing with specific aspects of MSOR and Key Skills, a small library of basic texts and four PCs linked to the School Intranet.

The PCs provide access to a range of mathematical software located on the School's servers as well as a number of Computer Assisted Learning (CAL) units held on CD ROMs. The Centre also acts as depository for lecturer's notes, provided by any lecturer who wishes to place his or her lecture notes on record. Photocopying facilities are provided and one corner is devoted to a quiet sitting area where students can read the various magazines provided.

The overall responsibility of the OLRC falls to an academic but it is supervised by a full-time administrator who is responsible for the day-to-day smooth running of the Centre. He acts, inter-alia, as librarian, issuing books, short-term loan items and print credits as well as managing the small shop that sells stationery items and various computer related items. All items are sold as near cost as can be managed.

What Support Was Needed?

The support that was required to initiate the Centre came from the Dean and in the early days the cost was minimal. The only real cost was the room as the part-time technician who looked after the Centre had other duties to attend to. The aim was to provide a quiet area where a lecturer could discuss academic problems with a small group of students away from his or her office. As time progressed support was given by the Dean to enable a positive response to student demand. The University operates a Devolved Revenue policy and so the financial support that is now required to run the Centre comes from the School. This provides the resources to employ the administrator and to provide time-tabled academic hours for six academics who act as daily tutors. In addition, the Centre has a budget from which it purchases all the stock that it sells via the shop as well as other items that help to improve the service provided. For example, last year the Centre purchased a heat-binder so that students could bind their Project Reports in a more professional manner than is possible with the comb binder.

The Barriers

When the original idea was mooted there were no barriers because it had the full support of the then Dean of the School. The only perceived barrier was the size of the facility to be afforded. The principle has always been one of active support for student-centred learning coupled with a desire to meet student demand as near as possible. In the early days the Centre had no budget allocation and so had to ask the School for any items that were needed. In practice, provided a good case was made, there was very little resistance from the School. Now, the Centre has its own budget which is used to purchase supplies for both the shop and the Centre.

The Enablers

The Centre was originally envisaged as providing a facility for the School's students, both in computing subjects and MSOR. The MSOR team soon came to realize the potential offered by the Centre and because the MSOR team derive much of their work from service teaching it was widely advertised and has become used by students from all over the University.

Evidence of Success

The success of the Centre can be measured by the amount it is used, which is significant. As time has progressed the Centre has grown from a small room used occasionally by a handful of students to the significant facility it now is with over 18,000 student study-visits and a further 12,000 shop-visits each year. It was also commended by the QAA Visiting Panel during a recent Teaching Quality Assessment.

How Can Other Academic Reproduce This?

By starting small and demonstrating that a demand is there. Attempting to meet the demand will inevitably cause the provision to grow. What is essential is an experienced MSOR team of academics who are willing and able to walk into a problem blind on a one-to-one basis and try to solve it for the student. Furthermore, if they feel they cannot solve it they need to know that they have at least one colleague to whom they could refer the problem without the colleague feeling that they are being put upon. The system runs as a team effort by the academics with individuals being rewarded by their time spent in the OLRC being recorded as part of their teaching commitment. As always it is down to the personalities involved and their generosity of spirit.

Quality Assurance

The quality of the provision is continually monitored by attention to student requests and suggestions. The provision of learning aids are also periodically reviewed and, where necessary, updated.

Other Recommendations

- Collect a team of willing academics.
- Find a reasonable location. If possible choose a location where staff can congregate as well – near a kettle is a very good place.
- Start small, don't be too ambitious to begin with.
- Advertise as widely as possible.
- Be absolutely regular with assistance. The students need to know that if they turn up at a given hour there will be someone there to assist.
- Let the students drive the development.

Study Advice Services incorporating the Mathematical Advice and Co-ordination Service at The University of Hull

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Abstract

Mathematical Advice and Co-ordination Service (MACS) was established in 1995 within the Faculty of Mathematics to support students within their studies at the University and to help prepare them to go into the world. Funding was made available for an initial period of 3 years and was then continued on a year-to-year basis. The emphasis has changed over the years and most of the work is now linked to students' current problems but also includes help for those facing employers' tests at interview. The University accepted that the concept of student support offered in Mathematics needed to be extended into other areas and, through The Higher Education Funding Council for England (HEFCE), established the Student Advice Service (SAS). The SAS is now a permanent feature of the University serving any member of the student body (and indeed staff) who might benefit from what it offers. The remainder of this case study considers only the mathematical part of the SAS, though many of the comments apply to the other areas of the SAS (Academic English, Study Skills and ICT).

The Execution

In 1993, in response to concerns about the levels of mathematical competence and understanding which students brought with them to their degree courses, the University set up a working party to consider the problem. It was recommended that many of the problems outlined by various departments could be addressed through a university-wide co-ordination of mathematics provision utilising the expertise and experience that exists and using the Mathematics Department as a base. The service was called the Mathematics Advisory and Co-ordination Service (MACS) and officially started in September 1995, with the appointment of its first co-ordinator, an experienced teacher in both FE and HE who did a lot of hard work to get MACS established. His appointment was to work 0.6 with MACS and 0.4 in the Mathematics Department. He was supported by a part-time lecturer who had been involved in the Numeracy Centre and who ran a course each year "Number from an Adult Viewpoint".

It was intended that MACS would include support of students (as is now provided) along with advice to departments on content and delivery of the mathematical content of courses and also to run Free Elective Modules on Life Skills such as "Statistics for Life" etc. Only one of the modules attracted sufficient students to make it viable (Graphical Interpretation of Data), the others were dropped after 3 years. The intention to give "advice to departments" has had some limited success in mathematics and engineering but most departments see it as interference!

In 1998 it was realised that we needed to expand the provision of Student Support to other areas. In January 2001 the Study Advice Services (SAS) started and MACS became part of it.

What Support Was Needed?

The Service was initially managed by an experienced university lecturer who with experience of school teaching, assisted by a lecturer who had developed the Numeracy Centre, both of whom had experience of dealing with 'problems in maths' at many levels. The management was taken on by a teacher with a wide experience of teaching pupils/students of all ages from 11+ and at all levels from Remedial to A level Further Mathematics. No training was offered and, indeed, it is difficult to see how training could be given. The main requirement for the tutor is to be able to recognise different methods used and to pare away the layers of a problem until the, often deep seated, underlying difficulty can be found. This is something that comes from experience rather than training. The second tutor has considerable experience in dealing with numeracy (with adults), with employers' tests and other areas of Mathematics.

The Barriers

There have been two main barriers over the years. The first is the (natural) reluctance of many students to seek help and as a consequence many students have come along when it is almost too late! Attempts to get to groups of students felt to be 'at risk' were not always successful. Usually it was the mature students who came for help, often followed by others.

The second barrier is a suspicion on the part of staff who view the activities of the service as being somehow threatening. Some gave the impression that their students had had no trouble in the past so there could be no reason why they were having trouble now. After considerable, almost secretive, work this barrier has fallen in some areas. Lecturers have realised that their students don't come with the same mathematical content as 10 years ago as the syllabuses have changed. Two lecturers have actually given me copies of their notes for me to comment on!

The Enablers

Since the SAS started the service has grown considerably as one member has the responsibility for liaison. This has enabled the service to advertise in faculties and departments. Contacts through the Student Counselling Service and through the Students Union prove invaluable. As a result the numbers coming for help have grown and it would not be possible for the mathematics tutor to cover all the responsibilities originally intended.

Evidence of Success

One source of evidence is the statistical records we keep. In mathematics, in the first semester (semester 2 of 2000-2001) we had 179 student-visits. This does not mean 179 individuals as each visit is counted – realistically we probably saw about 80/90 students. We also worked with 202 students in "workshops" – this may mean a department-organised group or a group of students getting together and asking for a group session, where a group may mean anything from 3 to 7 or 8. In semester 1 of 2001-2002 we had 144 student-visits and 397 students in "workshops". We have been represented, and interviewed for, a number of TQA assessments with complimentary comments being recorded in the final reports. We receive written comments from students and also many students come back to see us to thank us for 'getting them through their exams.' Others have admitted that we were the last resort before quitting their degree course and the University. The SAS is seen as a major factor in ensuring a high retention of students.

How Can Other Academics Reproduce This?

The simple answer is "with difficulty" unless they have the financial backing of the University and the support of major users of mathematics. There are many lecturers decrying the mathematical ability of their students but unless they band together to make serious provision for support within their own institution very little will happen. It will take the vision of one or two dedicated 'teachers' of mathematics and may need a department/faculty to offer initial funding to start the ball rolling. Once the beneficial effects of retention, more students succeeding and more student satisfaction are recognised then funds will be found from somewhere.

Quality Assurance

This has always been a problem. We have tried different ways of getting critical feedback including inviting students to attend informal chat sessions led by someone other than a tutor, email random shots, asking students to fill in a comment sheet etc. On the whole the only response has been from those satisfied with the service who have said kind things and, because it's worked for them, have had no criticisms.

Other Recommendations

- The Centre is not the only place where students get help and it is essential that there is sufficient communication between the agencies involved to maximise the support without confusing the issues.
- The use of Graduate Teaching Assistants (GTAs) to run Tutorial sessions is good for most GTAs and most students but they do need some insight into the problems met by students. On the whole for some undergraduates the GTAs are "too good at Mathematics"! They cannot understand the problems the undergraduates face, it's 'obvious' to them. In some cases they are not aware of different techniques in tackling a mathematical problem (i.e. there are at least 4 ways of doing simultaneous equations and some overseas students are taught the determinant method!).
- Language is one of the problems that appears quite often, when lecturers who are not native English speakers are teaching students who are also not native English speakers. The support and advice of 'experts' in EFL can be useful here along with Language Institutes.
- Confidentiality – we aim to provide a confidential service. Because of the physical situation of our desk this is not always easy but we do take students to a more private location when necessary. The main problem arises when you get a large number of students coming along for help who are all taking the same module. They do tend to talk about why they believe they have the problems and blame the lecturer! In some cases it appears that they are correct, though it's important that you never show that you agree with them. In other cases it is possible to show them that the problem is elsewhere, including not covering the topic before coming to University, or not learning it properly!
- It should be possible to feed information back to lecturers (or departments) when there does appear to be a problem with the module content or a lack of realisation on the part of the department that both GCSE and A level Mathematics has changed over the past 10 years! This can be done if confidentiality is not compromised.
- Most of the problems dealt with are up to the A level Further Maths of 10 years ago. Some problems are beyond that and, unless the tutor knows the topics or is willing to do some learning, the advice has to be "go and see your lecturer" – this is often not what the students wants to hear! In practice it is often not too difficult to work through the student's notes and, by explaining what's going on, learn something new. It is surprising just how often mistakes are found in notes which the student may suspect but lack the confidence to change.
- It is hard but very enjoyable work. If anyone is thinking of doing it then they should get together with one or two others and try and get something started. It will be of benefit to the students, the subject areas and the Institution and, probably the best selling line, it retains students and so saves money in the end!

The Weekly Mathematics Clinic at the University of Derby

Val Lowndes ▪ School of Computing and Technology ▪ University of Derby

Abstract

The Mathematics Clinic is provided throughout the 'teaching year'.

- *Offered on a drop-in basis to ALL university students accessing mathematical modules.*
- *Timetabled to be accessible to all Stage One and Stage Two specialist mathematics students, (main users: Stage One students in first semester).*
- *Clinic is staffed by friendly, approachable and experienced members of staff.*
- *Feedback confirms student appreciation of this facility.*

The Execution

A fundamental aim of the specialist programmes which comprise the Undergraduate Mathematics Scheme at the University of Derby, is to enable wide access and facilitate the development of mathematical skills in students who on entry may not be well qualified in terms of traditional qualifications in A Level mathematics. The provision of appropriate support has therefore been an inherent component of the scheme since its outset and the monitoring and enhancement of that support an ongoing feature. One component of that support is our Drop-in Mathematics Clinic.

A weekly Mathematics Clinic is provided throughout the 'teaching year'. This is offered on a drop-in basis to ALL university students accessing mathematical modules and is well-used. The clinic is timetabled to be accessible to all Stage One and Stage Two specialist mathematics students. However the main users are Stage One students (specialist and computing).

The Clinic is available one morning per week from 09:00-12:00 and students can 'drop-in' at any time; no appointments are necessary. One experienced member of staff is always available, with a further member of staff 'on-call' should there be an expectation of increased demand. Final year students, particularly those with a career interest in teaching, are sometimes willing to assist on an occasional voluntary basis.

What Support Was Needed?

The key components to the success of the Drop-in Clinic are:

- students quickly realise that they can have confidence that they will receive both sympathetic support and expertise appropriate to their needs;
- the clinic is timetabled alongside Stage One and Two mathematics modules, ensuring its availability to all specialist mathematics students;
- it is resourced appropriately with respect to rooming and PC facilities.

The Barriers

Barriers to success occur if there is difficulty in providing any of the resources for the above three components. This is likely to occur in factors outside of our 'local control', for example

- inadequate size room, inhibiting staff access to individual students.
- timetabling difficulties (e.g. engineering, science subject students, clinic times may clash with lectures/tutorials).

The Enablers

It is essential to continuously remind prospective customers of the existence of the Mathematics Clinic. Strategies include:

- the Clinic specified on student timetables;
- promoted during Induction and advertised via the School Website and School Noticeboards. However it is notable that students are more likely to turn up following a more specific reminder;
- A notice on Stage 1 Computing Noticeboard saying "Have YOU got a resit exam in Maths for Computing? Drop in to the Tuesday Maths Clinic" …etc;
- reminders to staff to promote the clinic to their students in lectures/tutorials;
- personal tutors encouraging their tutees to attend to help overcome difficulties induced by absence or poor time management etc.

The ultimate requirement is supportive staff both manning the clinic and encouraging students to attend!

Evidence of Success

Student feedback has been well documented over the years indicating both the success and the appreciation of this provision from the student perspective.

It is important however to keep a log of student participation. Individual names are not required, but the following information is necessary:

- numbers attending and from which programmes;
- specific topic/area of advice.

This information can usefully:

- enable further help-sessions to be organised;
- assist in decisions as to appropriate staffing of the clinic;
- provide important feedback to module leaders/teams with respect to appropriateness of module content or their expectations of prerequisite knowledge.

How Can Other Academics Reproduce This?

The initial requirement is for a mathematics department to identify whether their students and staff would benefit from the provision of a Drop-in facility such as the Maths Clinic. As mentioned before supportive staff are key to the success of this facility. Staff not directly involved in the Clinic provision should generally benefit, e.g. small groups of students taking problems to the Clinic rather than as individuals requiring personal sessions with individual tutors, actually enables more effective use of staff time.

Support from your Head of Department/Division is essential, in order to achieve appropriate staffing. The extent to which you can extend the support to servicing the mathematical needs of other subject areas will depend very much on the way your Institution structures and manages its financing of Schools/ Faculties.

Quality Assurance

In each Academic year, one member of staff is designated as having responsibility for the organisation of the Mathematics Clinic and reports back to the relevant committee i.e. Undergraduate Mathematics Programmes/Applicable Mathematics and Statistics Subject Committee. The performance of the Clinic with respect to usage and student feedback is reviewed as part of the annual monitoring of the Mathematical Programmes and Subject provision.

Other Recommendations

In addition to the Clinic provision described above, further clinics, specifically to support software packages (e.g. Minitab, Matlab, etc.) are scheduled at appropriate points in the Academic Year.

An important requirement in the operation of the clinic is an awareness by the ‘facilitators’ of current assignment specifications and deadlines and the extent to which direct or indirect help is appropriate. In the early days of running the clinic students did try to ‘hoodwink’ the facilitator into providing illicit help! This is to be avoided as it actually inhibits the deeper student learning which the clinic is aiming to encourage. This again returns to the fundamental requirement that the Clinic is staffed by experienced tutors.

The Education Drop-in Centre at the University of Glamorgan

Liz Staddon and Lowri Newman
Learning Resource Centre ▪ University of Glamorgan

Abstract

The education Drop-in Centre at the University of Glamorgan was established during the academic year 1996/97. Its aim has always been to provide generic study support for students with writing and study skills as well as mathematics and statistics skills. Since its creation the Centre has been through a variety of changes in terms of staffing and layout. It has grown steadily each year and now comprises of two sites and seventeen staff, three full-time administrators and fourteen part-time tutors. The Centre is seen to play a key part in retaining students and has become part of the fabric of the University.

The Execution

Members from what is now called the Centre for Lifelong Learning created the Centre during the academic year 1996/1997. It was felt that rising student numbers and modularization was making it more difficult for students to access the sources of help and advice that were available to them and that a comfortable and open space in the Learning Resource Centre (LRC) would enable them to meet and discuss study issues, access study resources and attend surgeries on designated topics.

A senior lecturer agreed to manage the Centre and a temporary assistant was appointed to set it up and deal with student enquiries. A lot of care was put into the location and ambience of the Centre, the aim being to create a space that was easily accessible, open and welcoming. The final result was a windowed construction placed in the centre of the book collection. Guidance materials were gathered on maths, IT, academic writing and general study skills such as time management and revision technique. Specialist maths support was provided by two lecturers from the University's maths division on part-time secondments. Records of users were kept from September 1997 and the Centre recorded 1140 callers in its first full year.

Changes and Developments

Since opening, we have experimented with different Centre layouts and staffing arrangements. Early visitors expressed a wish for private, as well as open spaces. In the summer of 1999 the Centre relocated to a slightly quieter alcove in the LRC which meant that two closed areas could be created with screens. Regarding staff, the Centre requires two sorts: friendly front-deskers who can deal with diverse inquires during office hours, and tutors with broad expertise who are familiar with the University's curricula. We have combined these differently over the years, and have discovered the following:

- Front-deskers need periods of time away from the Centre because its 'drop-in' nature can be overwhelming. Job-shares work well and final year students can provide excellent cover.
- Front-deskers must be protected from long guidance sessions because they need to be on the lookout for hesitant newcomers.
- Tutors must be both highly skilled and friendly.
- Staff, most of whom are part-time, value opportunities to meet so they can share experiences and gain a sense of belonging.

The Centre Now

The Centre has attracted more users every year, and careful record keeping has strengthened requests for extra resourcing. In September 2001 we were allocated monies from the widening access fund which meant we could open a second Centre at the University's Glyntaff site, extend opening hours to 7pm and employ extra staff. We now total 17: a manager, two highly qualified full-time administrators and 14 part-time tutors (4 of these teach maths).

What Support Was Needed?

Student needs: Most students who come for maths support need basic tuition: they need clear and slow explanations and to be reassured that they are not foolish. Some students need firmer encouragement to become responsible for their own learning. Most students opt for one-to-one tuition rather than self-help resources.

Staff needs: Practically, maths tutors need warning if students make unusual requests for help and they need access to SPSS and paper support materials. Developmentally, they need opportunities to discuss possible improvements and approaches to one-to-one tutoring: the main challenge seems to be recognizing when students become over dependent and knowing how to deal with it. In September 2001 we began an informal staff development programme: we pay all part-timers to attend three sessions per year which includes training in one-to-one tutoring, opportunities to discuss current issues and updates on other support mechanisms at the University.

Getting the Message Across

It took several years to establish the Centre as integral to University life. The trick seems to be inclusion in mainstream activities and information materials. The LRC includes the Centre in its induction video so that all incoming students learn about us. We also run workshops on school induction programmes because face-to-face contact seems to be so much more effective than leafleting. We believe that it is especially important to win the support of teaching staff so that they refer students to us when they spot a need. The maths division, which services all maths teaching at the University, is especially active in encouraging students to use the Centre during term time. Most Centre tutors also teach on mainstream programmes and so we can guarantee continuity and quality.

The Challenges

- Academic schools quite naturally deal with teaching and learning matters internally and a generic study support facility can easily be seen as second best. It has taken some time to convince colleagues (and I'm sure we haven't succeeded fully) that our study skills facility is beneficial to their students. To address this, we work with subject specialists whenever possible and often employ tutors who are also part-time lecturers on mainstream courses.
- Knowing how to staff the Centre effectively and economically is challenging for two reasons. First, staff may be required to do very simple and very sophisticated tasks. For example a student might require a handout on some simple procedure or complex guidance with aspects of a post-graduate dissertation. Second, attendance at the Centre is erratic: sometimes extra tutorial support is required and sometimes slots remain vacant. Some wastage is unavoidable and of course students don't always turn up to pre-booked sessions, but we seem to have reached a fair compromise by making a clear distinction between the front-desk and tutor roles and by having a team of tutors on standby to meet extra demand. Front-deskers sometimes switch between roles and are paid accordingly.
- As we get busier, it is harder to maintain the 'drop-in' flavour of the Centre. We have less flexible time to spend with students and this could mean that those with concerns don't have an opportunity to air them.
- It is obviously important to demonstrate the worth of the Centre. It is reasonably straightforward to keep records of users, but it is not so easy to demonstrate our contribution to student achievement and retention. We keep anecdotal records of feedback, but still need to find better ways to measure our impact without intimidating our visitors.

Evidence of Success

The number of visits has increased steadily each year: each time the service is extended, the demand grows. The number of maths tutorials delivered during Semester A 2001/2002 was 209. Many of our visitors return and yearly snapshot questionnaire responses indicate a high level of student satisfaction.

At a University level, the Centre's activity has recently been incorporated into the University's Annual Monitoring Exercise: we submit a yearly report which is then reviewed by our Quality Assurance Committee.

How Can Other Academics Reproduce this?

The following list of recommendations summarizes what we consider to be the most important features of a successful study support facility.

- Location

A study support centre works best if it is part of the main activity of a university or college. Users should be able to come across the centre whilst doing other business. Once there, there should be opportunities to browse in open spaces and to be somewhere more secluded for one-to-one or small group tutorials.

- Line management

It can be difficult to know where a study support facility fits in terms of line-management. It obviously doesn't sit easily in an individual teaching school if it is to have a University-wide function. Other sensible options seem to be learning resource centres, student service departments and variations of teaching and learning units. Each obviously has its own culture and emphases and these must be weighed carefully against the Centre's aims. We have tried to maintain a teaching and learning bias rather than a specific learning needs or resource one.

- Staff mix

We have found it best not to combine the general guidance and tutor roles. We lose out on spontaneity because students can rarely just 'drop in' for immediate specialist support, but we guarantee students some kind of attention almost immediately and maximize tutor time by pre-arranging all tutorials.

- Friendliness and firmness

All staff must have friendly dispositions because most students feel vulnerable on first visits and sometimes study problems mask deeper personal problems. They must also learn to create mental boundaries so that students do not expect too much from them in terms of help and time.

- Engaging support from academic schools

Any general support facility has to work extra hard to gain recognition and respect from individual teaching schools. Using school recommended tutors has been the best way for us to build bridges. We are always quick to respond when a school approaches us to deliver a study skills programme and we work very hard to tailor our delivery to particular student groups.

- Staff development

It wasn't until we began our staff development programme that we realized just how useful it is. It is odd to spend just a few hours working in the Centre without having a sense of its bigger aims and developments. Part-timers appreciate the chance to share experiences and we tend to carry similar concerns and insights. Making the most of the one-to-one learning encounter seems to require a lot of thought.

Student Support via Other Students

Student Proctors: A Peer Support System

Alan Davies and Andrew Fitzharris
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Abstract

The date of the formal introduction of student proctors within the Faculty of Engineering and Information Sciences is unclear. However, we have certainly been using student proctors for more than ten years. The purpose is to offer students the opportunity to learn from their peers in a one-to-one situation. Within the Faculty three departments have a student proctor programme each of which runs in much the same way but with differences which reflect the different custom and practice of each department.

The Execution

Student Proctors were introduced in the Faculty of Engineering and Information Sciences in the early 1990's. The aims of this service were to:

- provide students with an additional level of academic support i.e. beyond that provided by staff.
- allow students to learn from their peers in a one-to-one situation.

Proctors are appointed in the areas of Engineering, Computer Science and Mathematics. The number of proctors appointed each year varies between departments. In the 2001/2002 academic year there are 6 engineering proctors, 10 computer science proctors and 1 mathematics proctor. These numbers reflect the number of undergraduate students studying in each of these subject areas.

The mechanism for appointing proctors also varies between departments. In Engineering and Mathematics adverts are placed on the student notice boards in the summer term inviting applications from second year undergraduate students for posts commencing in the following autumn term. Candidates are required to have an appropriate academic background, e.g. a first class or upper second class profile to date, appropriate personal skills, e.g. be well organised, be able to communicate clearly, be patient with students with difficulties and to have an interest in helping others. All applicants are interviewed by staff and appointments are made shortly afterwards. In Computer Science a different system is used. Here, students with an interest in becoming proctors are invited to help out at programming practical sessions in the spring and summer terms of their second year. Those showing a particular aptitude for this work are then short listed, interviewed and appointed early in the following autumn term.

Each proctor is usually available for 2 or 3 hours each week. Details of their location and availability are published on the student notice boards. At these times the students requiring help can see the proctors on a drop-in basis i.e. without an appointment. In Engineering and Mathematics the proctors attempt to provide support on any technical problem in their subject area. In Computer Science the support is more specialised i.e. the proctors provide help only in specific subject areas e.g. particular programming languages. The proctors are not expected to be able to deal with every problem they are given. In all departments experienced academic staff are available to provide backup to the proctors when required.

The introduction of proctors has been a success and evidence shows that students make good use of the service, especially approaching coursework deadlines and examinations. The support provided by the student proctors is often different from that provided by academic staff, i.e. the proctors have usually been through the same courses as those seeking help and can often bring a different perspective to each problem.

What Support Was Needed?

The training given to proctors at the beginning of the year is limited. They are usually briefed about their role by the supervising member of staff and given formal terms of reference. The proctors are asked to report any problems arising to this member of staff so that they can be dealt with. This system has proved to be successful.

The Barriers

No major barriers have been identified with this system.

The Enablers

To encourage students to make use of the proctors adverts are placed on the student notice boards. In the Department of Mathematics the proctor also meets with students on all years of the scheme at the beginning of the academic year to explain their role, publicise the service and to inform the students when and where they will be available.

Evidence of Success

The operation of the proctor service is monitored carefully by staff in each Department. Records are kept of the number of students using the service, the nature of their problems and the details of the help they are given. In Engineering and Computer Science this information is reviewed regularly by staff to ensure that the system is viable, i.e. it is being used and is running successfully. In the Department of Mathematics the student proctor is required to provide a written report on the operation of the system twice each year to the committee that oversees the operation of the Mathematics Degree. All the reports received so far indicate that the system is used by students and is relatively problem free.

How Can Other Academics Reproduce This?

A student proctor service is relatively easy to set up. A member of staff is required in each department to initiate the system and to oversee its operation. The proctors also need to have a base so that they are easily accessible to students. This can be an office, a drop-in centre or a teaching laboratory. The main expense involved is the wages paid to the proctors. In the Faculty of Engineering and Information Sciences the proctors are paid on a hourly basis at the current rate of £5.32 per hour.

Quality Assurance

The operation of the student proctor service is described in the Annual Monitoring and Evaluation Reports written by the Course Leaders of the degree schemes run by the faculty. These reports are considered in detail each year by the Faculty Academic Quality Committee to ensure that any problems associated with the schemes, e.g. with the student proctor service, have been addressed adequately.

Other Recommendations

If a student proctor service is introduced it is essential that:

- The service is not used as a replacement for the traditional academic support provided by staff e.g. lectures, tutorials, etc.
- The staff responsible for the service are committed to its successful operation.
- Only proctors with the appropriate personal and academic qualities are appointed. Students are unlikely to make use of a service which is provided by proctors who are unsympathetic or who have weak academic backgrounds.
- Adequate resources are made available i.e. staff time, money and an appropriate meeting place.
- The operation of the service is monitored carefully by staff so that problems can be dealt with as soon as they arise.

Peer Support in Mathematics at the University of Leicester

Jeremy Levesley ▪ Department of Maths and Computing Science ▪ University of Leicester

Abstract

Peer Support (PS) has been running in the Department of Mathematics and Computer Science at the University of Leicester for the past 9 years. In this scheme students from the second and third years (called leaders from now on) help first year students in their efforts to assimilate first year material. The help occurs in small timetabled groups containing up to 8 or 10 first years and 2 to 4 leaders. In its first year the scheme had 6 second year leaders and now we have typically between 15 and 20 second and third year leaders. The number of first year students taking part in the scheme has also grown from about 10% of students in the early years to around 50% of students making some use of the scheme at some stage in the year.

The Execution

Peer Support is a local name for Supplemental Instruction (SI), a peer assisted learning scheme employed in a number of Further and Higher Education institutions throughout the UK. In this case study we will discuss the implementation of this scheme in the Department of Mathematics at the University of Leicester.

Peer Support at Leicester grew from a module in which third year students who had completed the module in the previous year were used as helpers in workshops, where material was delivered via guided exercises. The central idea is that people learn best from those who are closest to them in experience, because the 'teacher' still remembers what it was like to struggle with the information and the 'learner' is not intimidated by the expertise of the 'teacher'. This module was supported by a Teaching and Learning Initiative in HE.

The Director of the Student Learning Centre, knowing of this work in the Department of Mathematics and Computer Science at Leicester then invited Jenni Wallace, the then UK coordinator of SI, to train a number of second year mathematics students (leaders) to support the learning of first year students. The training took 2 days, and consisted of instruction in the main principles of SI, in group management techniques, and in managing and promoting the scheme.

It was decided that Jeremy Levesley would receive training at the University of Kansas City at Missouri in running an SI programme, so that he could do the student training in future, and administer a programme in the Department of Mathematics and Computer Science.

Currently, two training sessions for leaders per year are organised, one in June and one in September, just before the induction programme for the new first year students. First year students are recruited for training by particular invitation, often based on the recommendation of current leaders and also by general invitation via announcement in a lecture. Students self select from this point and occasionally decide that the programme is not for them as a result of the training.

The first training day is designed to introduce students to the key ideas of the scheme:

(a) leaders are not teachers and are not responsible for the delivery of information to students;

(b) assessed questions are not to be done in sessions – this is to prevent first years blaming leaders for incorrect answers.

Students receive training in group management techniques and in how to structure a session. The current leaders also come to the training to give the fledgling leaders the benefit of their experience. Promotion of the scheme is discussed, as well as the input of the leaders into the induction programme.

The second training day is used to prepare for induction. Leaders carefully plan their two sessions with the first years. Leaders are organised into teams and assigned a group of first year students and each leader will take a subgroup of approximately five to look after in particular. One session is more social, learning names etc., and the second is used to help students with key `A' level skills, in preparation for a skills assessment all students do. As soon as students start to receive assessments from modules the focus of sessions moves to these assessments. Sessions occur at timetabled times each week, usually attended by two to four leaders.

What Support Was Needed?

The scheme primarily requires the time of a dedicated member of staff and the willingness of a group of second year students. In some institutions leaders are paid for their involvement, but not in Leicester. In the early stages it helps to have an experienced external person to guide the initial set up. The department should support the scheme. Lecturers can provide specific questions for the sessions and be available to help second year students in supporting their modules. Financial support is required from the department to send students to the annual national SI conference.

The Barriers

The main barrier to the scheme is timetabling and rooming. Because second years and first years are involved there is little space on the timetable to fit sessions. There is then the problem of finding flat rooms, which the students can use. Because the times are often unsociable, and the rooms obscure, attendance can fall off. In many ways mathematics students have come to view mathematics as a private activity so the collaborative aspect of PS can be threatening in the initial stages. This also prevents some students from engaging.

The Enablers

The key enablers are the first and second year students. Good leading as well as active participation makes a successful scheme. The PS coordinator who supports leaders and administers the scheme (trains students, books rooms, photocopies etc.) is also important. The coordinator may also have an ongoing training role in helping leaders to deal with challenging situations which arise in the sessions. It goes without saying that suitable rooms and appropriate times are also key enabling features of the scheme.

Evidence of Success

We have come to view the scheme as being a success if most students have attended a couple of sessions and about a third of the students become more habitual attenders. It has taken 8 years for the scheme to be as well attended as this. The motivation of the second year students for their own studies is also a key indicator, for the scheme should be viewed as being as valuable to them as to the first years. It is difficult to assess the success of the scheme in terms of the performance of first year students. It remains an axiom that students improve their learning through discussion of the subject matter.

How Can Other Academics Reproduce This?

To reproduce the scheme will require a dedicated staff member (DSM) (preferably an academic) to run the scheme and an experienced external person to guide the department through the first training sessions with the students and setting up the scheme for the first year. Following this, the DSM should receive some training in how to train students in group management skills and running a successful session. The department should support the scheme, with positive comments in lectures etc. by other lecturing staff. Leaders will need to be selected who have no experience of such a scheme, so the opportunity for them to meet experienced leaders might also be helpful. Second year students often feel threatened because they do not feel expert enough. Students who have experienced PS as a user will worry less about this on the whole.

Quality Assurance

The nature of the scheme is that the sessions are unattended by academics. It is therefore difficult to monitor the quality of the scheme by direct observation. In the early years of the scheme members of the university's Teaching and Learning Unit visited sessions, but it was found that too much effort was required to monitor the sessions in this way. The key measures of usefulness of the sessions are attendance by the first years, which is generally good, the ease of recruiting students to the scheme and the response of the leaders to the scheme. Students get a sense of how our scheme compares to others when they attend (as one or two students per year do) the annual national SI conference. Those who attend feed back to the other students and improvements to the scheme can be made accordingly. Also, leaders are instrumental in designing the scheme for the following year. This is a natural way of improving quality in the scheme.

Other Recommendations

My main recommendations would be:

- Make sure that the department is supportive of the idea – many academics find the idea of students teaching students threatening. They should be reassured that no teaching is taking place.
- Have a member of staff to run the scheme who is very committed to the student helping student paradigm. The scheme requires a lot of effort to set up and maintain.
- Check that timetabling and rooming are at least feasible.
- Float the idea of the scheme with current students. This way you may be able to gauge their enthusiasm for such a scheme and you might also recruit your first set of leaders.

Summer Schools and Short Courses

Glasgow Caledonian University Mathematics Summer School

Jean Cook ▪ Department of Mathematics ▪ Glasgow Caledonian University

Abstract

The Summer School has operated on the same general principles since 1991. It helps prepare students for entry into programmes for which they have a conditional offer. It features tailored instruction, flexible attendance and delivery and continuous supportive feedback.

The Execution

The University decided in 1991 to run a pre-entry Summer School to help prepare students entering first year who have a time or a qualifications gap. Entry is by referral from an admissions tutor. There is no cost to the student and if a student matriculates, then he/she can claim travel expenses.

The Summer School is offered flexibly, with students able to attend one evening a week from Easter and then, in addition, during the day from the end of June. The Summer School finishes the week before registration. The three main entry points are as follows: post Easter for mature students who are making a return to education; late June for students who have the minimum qualifications for entry, but who are perceived by their admission tutors to have a weakness in mathematics; and early August, after the school exam results are published, for students who have failed to make the grade required in a conditional offer.

On the first day the student receives an information booklet giving full details of the operation and assessment, including the marking scheme for the required portfolio and an individualised progress chart giving details of the Computer Assisted Learning (CAL) lessons to be completed and the assessments to be undertaken. The average student is expected to complete the programme in 72 hours. The software (CALMAT) is available on most of the PCs on campus and can be purchased on a CD for home use. Completion data for CAL work done at home is merged with data on the campus server. Many students who purchase the system work at home, only attending supervised sessions when they need help or want to sit a test.

In addition to the progress chart containing the list of CAL lessons, each student is given paper-based materials related to the CAL lessons. We know that students use these materials in different ways, i.e. before, during or after using the software.

The required portfolio should contain learning plans, summaries, formulae and enough worked exercises to demonstrate competence in each section of the individualised syllabus.

The assessments are computer-delivered. They are not multiple choice. Mock tests are available and the actual tests are taken under supervised conditions.

What Support Was Needed?

The Summer School has been organised and facilitated from its inception by Mathematics Teachers who are familiar with the software used. Technical support was provided by faculty technicians in the early years; and latterly by the CALMAT group.

The Barriers

Prior to 2000, the software was loaded onto several servers on campus and the desktop faced by the student differed according to the room. In addition the student records were distributed over several servers. In 2000 a single server was acquired to deliver the software. This made life significantly easier for both staff and students.

Prior to summer 2001, the accommodation was in 20 seater computer rooms. This was costly and inefficient in the use of staff time. Because of the flexible attendance of students, something they value because it allows them to cope with either family commitments or part-time jobs, it was impossible to predict on any one day how many students would attend. In summer 2001 we had access to 80 computers in a single location in the library. The maximum number at any one session was 30 and a single tutor was able to cope.

Late applicants to the University are directed to the Summer School when the time to complete is insufficient. One might argue that some preparation before entry to the university is better than none, but their presence devalues the Summer School.

Each year, as registration time approached, admission tutors eager to meet their quota are tempted to convert conditional offers into unconditional ones. This results in some students not completing the Summer School.

Admissions Tutors sometimes have unrealistic ideas on what students can achieve during the period of the Summer School. This is demoralising for the students and impossible for the Summer School Tutors. Ten years down the line, this is still a problem!

The Enablers

Despite the difficulties that the flexible attendance has caused, we have maintained this aspect of delivery because of the advantages to the students. The availability of the large bank of computers and the single server has made this aspect of the delivery less of a nightmare.

The management system of the software provides continuous feedback to the student. The progress chart indicates what has still to be achieved. Without such feedback it would be difficult to monitor adequately the varied student body.

Every attempt is made to keep the number of different tutors that a student sees down to the minimum. This can be difficult over the summer period and we have been lucky in the last two years to employ a retired teacher as the main tutor.

The main Summer School office contacts students who are not making the progress expected. This is essential to keep Admission tutors informed on the number of students who are still holding places.

Evidence of Success

This is evidenced by the number of students who complete the Summer School and then go on to perform above average in the first year and later. Most of these students would not have been admitted to the university if they had not been able to attend the Summer School. One such student graduated with a first class honours in Statistics last year and is now reading for a PhD. Quotes from satisfied students include; “it allowed me to work at my own pace and concentrate on the areas where I had difficulty”, “I was never able to do this at school”, “it gave me a belief in myself” and “it was a lifeline”.

There are failures. These are mainly students who do not put in the effort. It is probably better that they fail at this stage rather than in the first year.

How Can Other Academics Reproduce This?

- The main aspect is the flexible delivery and the constant supportive feedback to large numbers of students. It is hard to see how this could be achieved without the use of software with the capability of monitoring performance and the employment of computer-based assessments.
- The other factor which had a significant impact on the operation was finding a suitable location. This would not have been a problem had the numbers been either small or predictable.
- Staffing over the summer can be a problem. If there are several tutors involved then it is desirable that one be available throughout to provide continuity.
- The extensive bank of materials has developed over the years. It should not be underestimated how long this would take to develop from scratch. An important element of this are the guidelines for assigning a progress chart to a new student.

Quality Assurance

- There are no formal mechanisms in place.
- 75% of last year’s Summer School were scheduled to enter programmes where the software used in the Summer School is an integral part of their learning experience in a first year module.

Reference

CALMAT; http://www.maths.gcal.ac.uk/calmat/; (13-09-02).

Mathematics Summer School at Bell College of Technology

Cameron Proctor ▪ Department of Sciences and Technology ▪ Bell College

Abstract

The Mathematics Summer School was run for the first time in September 2001, lasting one week immediately prior to the start of term. Many students admitted to courses in the School of Science and Technology are perceived to have major weaknesses in the type of fundamental algebra that underpins much of their analytical work, both in mathematics units per se and in other units. This development represents one strand of additional support given to such students; the fledgling Mathematics Support Unit can give such support as the course progresses. This initiative is not funded in any direct way and depends on the availability of already heavily committed staff.

The Execution

In recent years, it has been increasingly noticeable that significant numbers of students find major difficulties with elements of their course requiring any mathematical competence. The main area of weakness is in identifying how and when to use fundamental algebraic techniques. Much additional staff time has been spent in trying to redress the balance. Most of this has, however, been done in an ad hoc way.

In the last two years, an attempt has been made to try and provide some sort of framework for this extra provision. Staff have judged which students may benefit from such help; the Mathematics Support Unit was therefore established. These students were given additional timetabled help, often on a one-to-one basis. Results were frequently very successful; most of these students succeeded in passing their courses. However, this type of arrangement is very onerous in terms of staff time.

In the spring of 2001, the School of Science and Technology decided that the Mathematics and Physics section should run a one week summer school for new entrants. The Chemistry section has run a similar event for students undertaking that subject in biological sciences courses for some years, with apparently some success. The aim was to bring the algebraic skills of these students to a level that would allow them to cope with the mathematical elements of their course. Thereafter, those perceived with remaining difficulties could still attend the Mathematics Support Unit sessions.

College management could not see their way to finance the project for either staff training or the purchase of material. The Educational Development Officer was prepared to offer up to £300 for the purchase of suitable mathematical software. Staff evaluated several packages but found that any with a seemingly appropriate title, and within our price range, was either badly explained or not relevant to our needs.

Hence, staff decided to subdivide the material into a series of topics, have a short handout on each topic (usually 2 or 4 pages) followed by a tutorial sheet with answers. The tutorial sheets were made progressive in that they constantly involved an understanding of the previous topics.

What Support Was Needed?

Staff from other areas in the School provided back-up assistance to alleviate the pressure of time on Mathematics and Physics staff.

The Barriers

The Summer School was offered to all new HNC/D students in the disciplines mentioned. A large percentage of Computing students took up the offer but only a small percentage of the others decided to attend. Unfortunately, some may have not attended because they received notification too late to change other plans. Indeed, some did not receive notification until the School had already taken place. It is to be hoped that in the future college administration can ensure that relevant information is received on time. Further, it is intended to follow up those who have not attended, to see why this may have been the case.

Evidence of Success

Full results are presented in Table 1. Results seem to indicate there is less necessity for Computing students to attend, although there is some gain in them doing so. It seems that well nigh compulsory attendance for engineering entrants may be profitable. Indeed, given past experience, it may be worth extending provision to degree students on these (and other) courses.

How Can Other Academics Reproduce This?

Another institution would have to start by deciding on the topics and the level that were required to be taught at its summer school. They could examine the material available from other summer schools which is available and decide if it could be used with or without modification. Things to consider are the format (e.g. one week, several days, interleaved with other summer schools, etc.) of the course and how it will be presented (e.g. promoting self study techniques). Thereafter the institution requires staff time which is an internal problem.

Other Recommendations

All students who attended seemed to show some improvement in their algebraic skills; many indeed have been able to cope with the level of mathematics in their course. Mature students, in particular, showed greater confidence as well as refreshing their skills. Others, although showing clear signs of progress, were still well short of reaching a level that would allow them to cope. These students were easily identified and have been given tuition on a one-to-one basis throughout the year via the Mathematics Support Unit. In the majority of cases these students have steadily improved throughout the session, achieving some capability at the level of mathematics that they require.

Unfortunately some students steadfastly refused to come to the Mathematics Support Unit even with significant encouragement. Next year such encouragement will be increased, hopefully providing greater motivation for students to attend.

Notwithstanding our efforts and the successes we have had, it remains questionable at the very least, whether the type of provision currently available can completely address the many deep-rooted shortcomings developed over twelve years of school mathematics education.

It is known that other Higher Education institutions offer a similar type of Summer School. It would be useful if the LTSN MathsTEAM could make a list of these available along with detailed information about their content. In this way institutions could share ideas and experiences in order to improve their provision. We may find something that can improve our particular lot.

Table 1

Computing students

	Students scoring >50% in the initial test	Students scoring <50% in the initial test	All students
Number of students	15	9	24
Average percentage mark in the initial test	69%	28%	53%
Average percentage mark in the final test	91%	70%	83%
Average percentage improvement	22%	42%	30%

Non-computing students

	Students scoring >50% in the initial test	Students scoring <50% in the initial test	All students
Number of students	1	18	19
Average percentage mark in the initial test	52%	28%	29%
Average percentage mark in the final test	90%	57%	59%
Average percentage improvement	38%	29%	30%

All students

	Students scoring >50% in the initial test	Students scoring <50% in the initial test	All students
Number of students	16	27	43
Average percentage mark in the initial test	68%	28%	43%
Average percentage mark in the final test	91%	62%	73%
Average percentage improvement	23%	34%	30%

Fast Track Summer Mathematics Course at South Bank University

Susan Starkings ▪ Learning and Development Centre ▪ South Bank University

Abstract

The first summer mathematics course ran during July and August of 1997, financed by South Bank University (SBU). In subsequent years the course became HEFCE funded. The Fast Track mathematics course was a specifically designed free summer course to help equip the students with those skills required to enter a degree of Higher National Diploma in science or technology. SBU established the six week daytime course, which helped students identify gaps in their knowledge and provided a tailor made mathematics learning programme. This course now runs every summer to equip new students with the mathematical skills required for a smooth transition into university.

The Execution

The pilot Fast Track Summer Mathematics course at SBU first ran during the summer of 1997 and was considered a success, by both students and staff alike. The idea for the course came from discussions about the difficulties of recruiting students to our courses in engineering, science and the built environment. The greatest obstacle is often the lack of mathematical skills and the fear students have of repeating past failure at mathematics. Our idea was to offer potential students the chance to improve their mathematics in a friendly environment, which would build confidence, and also provide advice about the opportunities for further study at the university. This was our first attempt to promote community access to university courses in science and technology by enabling mature students with few formal qualifications to gain the necessary skills to progress.

The course was designed with the university's commitment to 'widening provision' in mind and had the aim of enabling progression for local people. Southwark, Lambeth and Lewisham are working class boroughs which have some of the lowest progression rates to HE in the country. Few people have backgrounds with any experience of HE at all and many adults lack formal qualifications.

For this reason, and because it was envisaged that many would be in low income groups or on state benefits, the course was offered free of charge. SBU funded the first course and subsequent courses are now HEFCE funded. To cater for those claiming benefit or who might be working part-time, the course offered 15 hours of taught/tutorial classes a week through morning sessions. Participants were also offered the option of extra 'drop in' sessions on a 'workshop' basis in the afternoons. This format is still in use for the course.

For the first course in 1997 an administrator was appointed on a part-time basis i.e.12 hours per week from April till August to deal with marketing, publicity and general administrative duties during this time period. Also a SBU academic member of staff was appointed to be responsible for the course development, collection and production of suitable material, assessment procedures and the general academic well being of the course. The course now comes under the umbrella of the Mathematics Support at SBU and hence part of the Learning and Development Centre's portfolio of courses. Course material has been collected over the last five years and is updated and modified as and when required.

The course has more than trebled in size (the first intake was just 60 students with 6 tutors) but we still only have a part time administrator, one full time academic member of SBU staff and 20 part-time tutors.

Publicity for the course is sent to local libraries and colleges. Responses come from a wide cross section of the community. Over half the applicants are on benefit. Most of the applicants are male; in spite of offering places to as many women as possible we felt met the criteria, they comprised only one fifth of the people enrolled on the course. The course has become very popular and heavily oversubscribed. More than 1000 applicants each year request places, some people even requesting their place a year in advance.

What Support Was Needed?

The Centre, since its inception in 1997, has been managed by an experienced university teacher (the course leader), who has prior first-hand experience of the difficulties mature students have in mathematics. The only staff training that is available is a short induction given by the course leader. For subsequent cohorts an experienced tutor of this course is teamed up with any new member of the teaching team to give support and guidance. For this reason it was vital, for its success, that SBU employed experienced, student friendly tutors to teach on this course. Some of these tutors now help out in the Learning and Development Centre support classes and hence can go on any of SBU staff development activities/courses. The tutors must be fully committed to the course and have a great deal of experience in teaching adults.

The Barriers

The first barrier that we encountered at SBU was the initial reluctance of admission tutors to recognise this course as being a useful mechanism to bring the potential student's mathematical ability up to the level required to study at the university. Other barriers included:

- Convincing university staff that the students on this course would attend every day for the six weeks and that the final assessment would be rigorous enough for the entry level required.
- The university funded the first course from central funds and this caused resentment from some faculties/departments who were not going to benefit from this course.

The Enablers

A great deal of ground work was done, especially in the early days, to promote the course around SBU and to the libraries and colleges in our local catchment area. The university's website promoted the course in the early years but now there appears to be no need since the reputation of the course has spread and we are oversubscribed. We are very fortunate in having recruited and retained committed knowledgeable staff with experience of FE/HE transition. The experience they have in syllabus content and required levels and teaching pedagogy has been, and still is, invaluable. Admissions tutors who looked 'favourably' on this venture were a real bonus and in turn have spread the word of how successful the course is to other admissions tutors. An academic member of staff who would be available during the summer months is also a requirement.

Adequate funding is a must and we were fortunate that our VC decided to pilot this course and hence we put in and were successful for HEFCE funding under widening participation. Appropriate accommodation in which to run the course is also an essential feature. This course has priority over room bookings during the summer period – hence we are able to book the same rooms for the whole six week period.

A 'Fast Track to Higher Education' leaflet is produced by SBU and is available to all interested parties and a one page A4 flyer/information sheet is sent to all admissions tutors in the February before the course starts.

Evidence of Success

The most important source of evidence for this course is successful students. We keep attendance registers to show to admissions tutors, who are not only interested in results but in the general attendance of the students on the course. We ask Course Directors to give us updates of students' progress and progression so that we can track successful students. Some of the students do not attain the required level and we refer them to FE colleges to do further study. It is reassuring to see these students two or three years later entering higher education. We keep records of entrance and exit results so that we can see how much a student has progressed in their mathematical ability from start to finish.

In addition to academic results we also use student evaluation questionnaires. Comments such as 'I loved and enjoyed the course which has really taken me a step further in mathematics' or 'Everything I learned was useful' provide a real boost to the tutors teaching on the course.

How Can Other Academics Reproduce This?

The setting up and running of this course takes a great deal of time and effort. A fully committed member of academic staff with appropriate experience is a must. One would need to set up and have in place the following:

- Funding to employ appropriate teaching staff and any resources that need to be purchased. (In our case this was mainly the photocopying budget).
- Good tutors with relevant experience of FE/HE transition.
- Useful text books or other paper based teaching materials.
- Providing taught classes and extra 'drop in' sessions for all students.
- The classrooms used need to be modern, well furnished with appropriate computer resources on hand or available when required.
- Guidance from admissions tutors on possible courses.
- Advice and guidance from tutors on further courses available for those students who have not yet acquired the appropriate level to enter the university.
- Administrative backup to support the course.
- A well organised and committed academic member of staff who will keep material for future courses, academic results, evaluation questionnaires and other associated resources.

Quality Assurance

The course has now undergone an internal validation process. The Fast Track provides all students with a course guide and mathematics unit guide. The course evaluation report is in line with the university's monitoring procedures.

Other Recommendations

My main recommendations would be, that if a HE institution wants to run a summer mathematics programme of this type the following issues need to be addressed and suitable procedures are in place before the course starts:

- Adequate funding is available to run the course.
- Ensure that adequate administrative and technical help is in place.
- State what type and level of students you wish to go on the course and what progression is open to them.
- Make sure that admissions tutors are in agreement with this course and its subsequent progression.
- Experienced tutors/teaching staff are available to teach on this course.
- Appropriate teaching material is available at the correct level for the teaching sessions along with additional material for the workshops.
- Diagnostic tests and final assessments need to be available or produced.
- If you use your existing full-time academic staff – this work is part of their contractual teaching duties and that they can have their holidays at other times in the academic year.
- It should be made clear to your establishment that this course alone cannot solve the admissions tutors' problems of recruitment to science and technology based courses. Also this is not a panacea that will resolve the many problems caused by an inadequate mathematics education system.

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Top-Up Courses at Napier University

Interview with Veronique Johnston ▪ Quality Enhancement Service ▪ Napier University
Interview with Fiona Campbell ▪ Life Long Learning Services ▪ Napier University

Abstract

Wider access students i.e. those people who have narrowly missed the entrance requirements, are given a chance to "top-up" their mathematical knowledge before entering Napier University. They can study at their own pace over the summer vacation. There is regular communication with a university tutor and extra study sessions are held during August at the University.

The Execution

The "Top-Up" programme began as a joint funded project between the Scottish Higher Education Funding Council and Department of Employment (1993-1994). It offered distance learning for the unemployed. Materials were produced in partnership with Glasgow Caledonian University and Robert Gordon University. Once the funding period had finished, it was decided that future applicants to Napier University would have the opportunity to use these resources.

During 1995 the programme was made available to the wider access students, i.e. those people who had narrowly missed the entrance requirements. Today it consists of three Top-Up Courses, in Maths (basic and advanced), Chemistry and Skills in Writing and Presenting. They are offered to all applicants, yet for many attending is a condition of entry to Napier University. The faculty will pay the course fee on this basis.

Participants in the maths course include students from the Business School, mature students doing the MBA, entrants into Sports and Exercise Science, and those enrolled for Social Sciences and Engineering. Once the applicant has registered, the course material is posted and a tutor is allocated. Last year twenty-nine students took part in the Maths Top-Up Course.

The courses run on a distance-learning basis. Two packs are available for the Maths Course in which there are worked examples, self-assessments and end of unit assessments. The first pack consists of a booklet, "Revise Your Maths" which introduces very basic arithmetic, gradually working the students towards a standard grade level. Every applicant is advised to complete this pack first. Students who are going into Engineering or Science will invariably progress to the second and more difficult pack.

Throughout the summer months the students are encouraged to work through the assignments and to mail the work to their tutor. This is marked and returned with feedback. The learning is basically flexible; however if the student is studying a course as a condition of entry then they are required to submit the end of unit assessments to the tutor for marking. This information is forwarded to the student's Admissions Tutor to provide an overview of progress. Overall students are encouraged to communicate frequently with their tutors.

Drop-In Sessions are provided in August over a two week period for approximately two hours per day. Last year the sessions were run two hours at mid-day and again two hours in the evening. The evening sessions proved most successful as they accommodated those students who were working or who had families. The sessions are not compulsory but students are strongly recommended to take advantage of the opportunity to work through sample papers or to tackle problem material with other students and their tutor. There is a final assessment at the end of the drop-in sessions. Overall the work is not marked on a pass/fail basis. The Admissions Tutor is informed as to how well the person has coped with the course, worked through the material and their attendance. Based on all this information the tutor will make the decision as to whether they will accept the student into the University or not.

What Support Was Needed?

- The programme is co-ordinated from the Wider Access Unit and the Life Long Learning Service Department.
- The tutors are paid from February to the end of September. They get £30 per month plus £1 per student head over 5, with the maximum of £20 per tutor. For the drop-in sessions they get £22.50 per hour.
- The students were given experience of MathCAD and Derive. Two factors have contributed to that no longer being available:
  a) Getting access to computer laboratories became impossible during the summer.
  b) The students were not advanced enough in their basic mathematical skills to consider further challenges; their main criterion was to study within the existing course structure.

The Barriers

The main difficulty is convincing the students that the course will assist them with their future studies. Once on the course they begin to appreciate the difficulties and what sort of level the course demands. These students by and large have not succeeded in the school system; many lack the motivation to do the assessments and the ability to work by themselves.

The Enablers

Admission staff send out leaflets to the applicants who fit the entrance criteria. Information is also included in the prospectus. As yet there is nothing up on the website. Leaflets are being taken to FE open events because of the large number of FE students who take the courses. They are also circulated at particular career adviser conferences.

Evidence of Success

During the two-week Drop-In Session the tutors get to know the small group of students very well. Their on-going attendance during this time indicates that they do find it a useful service.

How Can Other Academics Reproduce This?

- Appointing an administrator to run the courses is essential. This centralised role provides on-going support, answers to student queries and provides an essential liaison service between the tutors and the students.
- It is about listening to students and what they need.
- The material needs to be carefully chosen. In many cases universities try and reinvent the wheel by writing their own material. Maths does not change at this level. Up-to-date materials, e.g. “Top-Up Your Maths”, can be inspected on application to the Wider Access Team Administrator, email: **na.smith@napier.ac.uk**
- Getting the right people to teach is critical.
- The material provided should not be based on the school level.

Quality Assurance

There is no formal quality assurance. The course administrator reports on a monthly basis to the Wider Access Unit and works closely with the Head of the Wider Access on course developments. It is also raised in the Wider Access Development Group meetings which are attended by university wide representatives. They are largely programme leaders/ faculty reps and various central services (as appropriate). Anything that is happening in the course is raised and mentioned there.

Test-Based Support

Diagnostic Driven Support at UMIST

Colin Steele ▪ Department of Mathematics ▪ UMIST

Abstract

Students arriving in many of the UMIST departments are required to take a brief maths test on arrival. Mathematics students who underachieve on this test are assigned some questions relevant to sections where they did poorly and also referred to sections from texts and Internet notes. The student's attempt at the assigned questions acts as a basis for a feedback session. Certain students in other departments (receiving mathematics as a service course) are asked to complete a computerised assignment on areas where they underachieved. Again, they are provided with references to texts and Internet notes.

The Execution

The department of mathematics at UMIST has long tried to provide special treatment and classes for students who were seen to be underachieving. This applies both to mathematics students and to students in other departments. In 1993, some initiatives allowed special classes to be given to groups of students who started degrees in Engineering and similar courses but whose mathematics background was weak. Although a certain amount of success was seen in these classes, the fact that the system did not feed into assessment meant that fewer students were motivated to attend.

In 1996, Engineering and other students were streamed into courses on arrival at UMIST by means of a paper-based diagnostic test and previous qualifications (see page 6 for details). There were three streams i.e. P, Q and R with the P-stream being for the most able/advanced students and the R-stream for the least able/advanced. While this information made use of the overall score in the diagnostic test the distribution of marks across the topics was not being used. Quickly, the test was divided into 6 sections i.e. A: arithmetic, B: algebra, C: trigonometry and coordinates, D: logarithms and exponentials, E: differentiation and F: integration and stabilised at a length of 40 minutes for 24 questions. Marking was carried out by the author and around 8 postgraduate students working closely with him. Questions were simple to mark i.e. a numerical question or multiple choice or a simple algebraic expression. A simple analysis of results on a year-by-year basis shows a slight downward trend although the scatter is of a level consistent with the trend.

Many students on the Q-stream and a few students on the P-stream were carrying one or more weak sections i.e. a score of 2 or less out of 4. Such students were asked to attempt and hand-in work (paper based) on similar topics to those on which they underachieved in the diagnostic test (up to a maximum of two topics as chosen algorithmically by the Director of Service Teaching - when a student showed weakness in more than two sections, in general the two most basic sections were assigned). These questions counted as the first piece of coursework.

This scheme has evolved with time and is now in the following form. Students are still assigned one or two sections on the basis of the diagnostic test but now the follow-up assignment takes the form of a computer session with Question Mark for Windows rather than a paper-based assignment. Students are given the opportunity to download questions from a website that will look similar to the questions that the computer will ask. Students are also told of references to specific sections (e.g. by section or page number) from certain text books and some Internet notes written for this purpose on the relevant topic (see references). Help is also available in the regular weekly tutorials. The theory is that the students can spend time preparing themselves for the computerised sessions by getting familiar with the mathematical material and then, at a time of their own choosing (within publicised deadlines) carry out the test. Also available is a 'practice' test using Question Mark. The questions are trivial mathematically but they identify the two types of questions used i.e. multiple choice questions and numerical questions and show the students how to enter answers in each case.

For students on the Q-stream, each assignment counts 10% of the first semester coursework which, in turn, counts 20% of the total module. For the P-stream, relatively few students will be assigned this work and fewer still will be assigned two units; hence the work counts a total of 10% of the coursework mark. For both the P and the Q-streams, students who do well in all sections of the diagnostic test are exempted this work.

This work serves to familiarise (or re-familiarise) the students with topics on which they underachieved in the diagnostic test and to prepare them better for the rest of the course.

The followup sessions for the mathematics students are organised along different lines (e.g. no use of Question Mark) but the same diagnostic test is used. Five sessions were organised, corresponding to sections A, B, C, E and F. No session was organised for section D as so many students underachieved here; instead extra time was allocated to this topic in one of the lecture courses.

Students who scored a total of 12 out of 24 or less in the diagnostic test were asked to participate in all sessions except those where they scored 4 out of 4 in the relevant section of the diagnostic test. Students who scored 13 or more in the diagnostic test were asked to participate in sessions where they scored zero or one out of 4 in the corresponding section of the diagnostic test. The build-up to a session was organised as follows; about a week before the session, students were issued with a sheet giving questions on the relevant topic and were asked to hand in their attempts to the questions the day before the session. The sheet also gave references to sections of texts and some Internet notes (the same references as for the service course students). The member of staff in charge of the session looked at the work and made comments but did not assign a mark. The students' attempts at the questions formed the basis of the one-hour session but there were cases where the session evolved to cover other matters.

What Support Was Needed?

The Director of Service Teaching had been to several sessions regarding Computer Assisted Assessment e.g. at Birmingham University. Question Mark is a relatively easy package for the user and no special training was required although students had an opportunity to carry out a 'practice' test as many times as they desired. However, it was thought that a little time was necessary to get familiar with the package (at least for certain students) and so any temptation to use Question Mark for the original diagnostic test was resisted.

The Barriers and Enablers

For the service course students, carrying out assignments in their own time, with a mere six topics, answers might be passed from student to student. Answers were available after each question of the test in order to continue to help the students to learn. It was decided that each question would come in four slightly different versions (i.e. coefficients changed etc.) and the actual question chosen at random. This could not happen for all questions, as certain questions were required as follow-on from other questions e.g. a further question using the same coefficients. To enable these questions to follow each other, four different versions of each test were designed. Each version had a set of questions unique to that version and also a set of questions chosen at random. Thus, every time a student took a test, the test was unique and there is no evidence of sets of answers being passed around.

Participation rates in the sessions for Mathematics students are low and it is believed that the independent nature of these sessions is responsible. If a mark were to be derived from these sessions which were to feed into the coursework for one of the actual modules, then participation would probably be much higher. This matter is currently under review.

Evidence of Success

Several students completed the 'response' test to comment favourable on the scheme. It is not meaningful to comment on the comparison between students who were assigned to this procedure and those who were not as a) the students who were assigned to this procedure came in a certain band in the rankings from the diagnostic test, thus producing selection effects and b) such a comparison would involve a comparison with students following other initiatives rather than with a control sample.

How Can Other Academics Reproduce This?

Others can definitely reproduce this approach. It may have to be modified in light of the exact material required for the courses. Transferring the approach to non-scientific subjects (or indeed to certain scientific subjects) may require changes to the approach using Question Mark, as numerical type questions would have to be replaced by other questions e.g. 'word match', with associated problems. Question Mark Perception may be advantageous in establishments where it is fully supported.

Quality Assurance

In addition to the Question Mark modules devoted to the topics and the practice module, there is a module named 'response'. This is an opportunity for students to comment on any aspect of the system. The students have an opportunity to remain anonymous while making such comments. The system operates during the early weeks of semester 1, including week 3 when, for all modules, a questionnaire is run giving students the opportunity to comment on courses at an early stage. At the end of each course, full questionnaires are run for each course. In addition, students have the opportunity to comment through the staff-student council in the mathematics department or relevant other department or through the personal tutorial system.

Other Recommendations

Mathematics students: – Module lecturers who are aware of, and sympathetic to, the procedure certainly help. If the scheme is to run again in autumn 2002, relevant points are:

- It is essential to arrange a mechanism whereby the project feeds into the assessment of the students e.g. through the coursework component of one of the courses.
- The scheme should cope with changing circumstances e.g. Curriculum 2000 students entering the system.

Service course students:

- A campus computer network with many public clusters and a good reliability record certainly helped the project.
- It is necessary to provide each student with a paper document detailing what is required of him/her as an individual (or giving a reference to a website where this information can be found).

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Using Computer Based Tests to allow Multiple Attempts at Assessment

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Abstract

Computer based assessment has been used at UWE for a number of years on certain modules run by the School of Mathematical Sciences. In this case study we discuss the operation of the assessment for a first year engineering mathematics module in which students are permitted multiple attempts and are allowed, within an specified period of time, to choose when they take the assessment. Feedback from students has been highly positive about the assessment regime and our observation is that operating the tests in this way does encourage students to work steadily throughout the year.

The Execution

This case study is about the assessment of an engineering mathematics course delivered to all first year students registered on BEng programmes at UWE. Around 180 students who come from a wide variety of academic backgrounds are registered on the module. The most significant groups, in terms of numbers on the module, are students with 'A' level mathematics, those who passed our foundation year and overseas students with qualifications taken as equivalent to 'A' level. The coursework (30%) for the module consists of four computer based tests on Algebra and Functions, Calculus, Linear Constant Coefficient ODEs and Linear Algebra. To pass the module, students must obtain an overall mark of at least 40% subject to a minimum mark of 35% in both the coursework and the examination.

The decision to use computer based testing as a method of assessment in this module arose from the need to provide all students with regular and timely feedback as to the progress they were making in their mathematical studies. Weaker students needed to know the extent to which they were struggling, stronger students needed to know that they were making good progress. These aims had to be achieved without increasing the workload on academic staff.

The tests are designed to give the students a high degree of control over how they manage their time during the test period. Students are permitted three attempts at each test which they can take over a two week and a half week period. Students also have Internet access to the tests which are delivered using Questionmark Perception. The time permitted on a test is two hours although many complete the test in half this time.

All of the questions are presented so that students may answer the questions in any order they choose before submitting an attempt. This feature has the disadvantage in that any technical failure prior to submission results in the loss of the student's work. However, over the four years these tests have taken place, the students have expressed a strong view that this is their preferred mode of operation. If a technical problem occurs we normally grant an additional attempt. The mark for the test and any feedback is displayed immediately after the test has been submitted. The questions are randomly chosen from a bank of questions on a particular topic. Therefore, each student should receive a different test of comparable standard.

The operation of the tests has evolved over a four year period. Multiple attempts were introduced last year. Although initially suspicious of the software, students enjoy the flexibility this test regime offers. When asked to comment on the module during module evaluation, the computer based tests get a very positive response. It is interesting to note that not all students use all three attempts, including some with very modest scores. However, a significant number use the tests as planned and seek help in between attempts.

What Support Was Needed?

The project, which involved a number of mathematics modules, was initiated using Faculty funds set aside for developing new methods of assessment. This support was essential as it allowed staff to get to the stage where they could realize some of the benefits of reduced marking loads. These staff were then able to develop the question databank further. Technical support, principally connected with database management, was obtained from the on-line help service provided by Questionmark and from the Faculty's own IT support staff.

Students themselves require very little training in the use of the system. They get the opportunity to test the system out for themselves prior to the real tests taking place. They usually do this by themselves with the aid of a handout. Any student requiring additional help can receive this from their tutor.

The Barriers

Some academic staff were reluctant to support the development of computer based assessment. Often this reluctance is justified by the particular aims of a module, made more so by the fact that current software cannot test algebraic manipulation skills directly. This does limit the depth of understanding that can be assessed by this method although it is possible to design questions which test manipulation skills implicitly. The main point here is that at present computer based testing in mathematics can effectively test some skills and promote activity which we might describe as positively contributing to learning, but the method has its limitations and must be used appropriately.

There are a number of aspects of computer based testing which students find uncomfortable. Lack of "method" marks mean that small errors by the student can lead to a large penalty in marks lost. This problem can be moderated by careful design of the question and allocating multiple attempts. Any error in a question can clearly erode the confidence of the student in the system. Technical failures such as server crashes seriously disrupt the operation of the test, possibly compromising the pedagogic aims of the whole exercise.

The Enablers

The principal strategy adopted in encouraging student participation was compulsion! By making the tests part of the formal assessment of the module, students have to achieve an average mark of at least 35% in these tests. When initially piloting the test material we did offer the tests in a self-assessment mode. Student participation was not high. That said, students clearly like the flexibility in being able to choose when to make their attempts and appreciate the security of being able to have further attempts if required. The other significant factor in this exercise is that the tests are very simple to use, so while compulsion has clearly helped in promoting the use of the tests, the design of the tests greatly contribute to the way in which the tests are used.

Evidence of Success

Student feedback through module evaluation has been very positive about the use of computer based tests, especially the multiple attempts. In addition, we know that the tests encourage the students to work through previous exercises because of the questions they ask in tutorials and surgeries, between attempts! Since the multiple attempts have been introduced into the tests, the overall pass-rate for the module has improved. While this improvement could be the result of other changes that have taken place, it is likely that the tests have made a positive contribution towards this improvement.

How Can Other Academics Reproduce This?

The main issue in introducing computer based assessment is the initial work involved in developing the module. There must therefore be a strong commitment from the University and from individual staff. A considerable amount of work is being carried out in this area by many Universities, with some expectation that over the next few years much of this material may well be brought together and made available to the wider community. The single most useful thing somebody can do starting off down this route is to network with other academics. Some of the ideas used in our tests came from listening to the experiences of others at Learning Teaching and Support Network (LTSN) sponsored events.

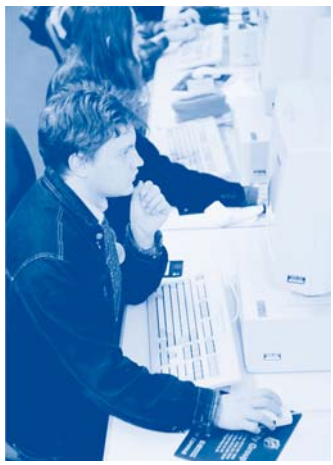
Quality Assurance

There are regular meetings held between the academic and IT support staff to review the operation of the computer based tests. All test questions in the data bank are attempted prior to publication on the system. Any errors which are found in any published question are logged with the IT manager and removed from the databank. The tests are moderated using the same procedures as any other piece of assessment within the University.

Other Recommendations

In addition to points made in the preceding text I would also recommend when developing computer based tests

- Ensure that there is adequate in house technical support available.
- Take time over the design of your question database so that it can be easily used by colleagues.
- If any part-time students are involved then it is essential that Internet access is available.
- Be careful that this method of testing does not lead to assessment overload on the student.
- Take care over feedback given in questions. Avoid making the feedback too module specific as you may want to use the question elsewhere.
- Establish a rigorous quality testing procedure for questions prior to publication.
- Be clear to students how you are going to deal with technical problems. You will not be able to avoid server failures but this problem will be easier to manage if the students remain calm!



A First Year Mathematics Transition Module based on Initial Assessment of the Skills of Incoming Students

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Abstract

The Transition Module is designed to audit the mathematical skills of incoming students and thereby design and implement appropriate teaching, learning and assessment strategies to ease the transition to university.

The Execution

- The first eight weeks of the first year is divided into four two-week blocks: Number and Algebra, Functions, Geometry and Trig, Introductory Calculus.
- Each block has six contact hours and students are expected to do a further six hours independent study.
- The first hour of each block is used for a paper-based formative objective (but not multiple choice) test for the block.
- From the results of the tests probable preparedness (average mark of all students on a given question, normed to one) values in each topic, for each type of prior qualification, are calculated. These values are then used to define the subsequent work on the block. The probable preparedness values can also be used to predict the skills possessed by any group of students with a known profile of prior qualifications.
- Immediately following the test the students are issued with:
  - Complete solutions to the test questions.
  - Outline revision notes in all areas of the topic.
  - Plentiful exercises of all levels of difficulty so that the students can reinforce their skills.
- The remaining five contact hours are devoted to revising and reinforcing the material of the block, using lectures, exercise classes, tutorials, depending on the nature of the area being addressed.
- Coursework is set every four weeks and focuses on areas that were found to be a problem for most students in the tests.

What Support Was Needed?

The module requires no more support than other modules, except for the increased staff time required for marking the tests.

The Barriers

One problem is that some students simply do not put in sufficient work. The module is designed so that such students can be identified within the first couple of weeks and a strategy for support can be put in place early on.

As the assessment is norm-referenced with a pass mark of 40% it is also inevitable that some of the students can just scrape through without achieving a majority of the learning outcomes.

A recent problem is that of GNVQ students whose performance is deemed, officially, to be A level equivalent. In practice many such students are in fact less well prepared than the conventional A level equivalent and so find the module too difficult. One answer to this is to stream students according to their initial assessment results.

The test results are sometimes based on small samples and the data obtained would be more useful and reliable if larger samples could be surveyed. To this end, with funding provided by the university, following seed-funding from the Learning Teaching and Support Network (LTSN), web-based initial assessment facilities are under development that can be used across the sector to extract more reliable data. Note that the prime motivation for this is to provide more reliable statistical data to support its use as a research and development tool in the enhancement of provision. For the purposes of supporting individual groups of students there are in fact reasons to prefer properly constructed paper-based objective tests to computer-based tests: the marking is not that onerous (each test, for 150 students takes just a few hours to mark); in manual marking the lecturer can pick up useful pointers to common problems and the students' approaches to them; one quickly gets to know those students who need particular help; it tells you a lot about the students and this can be used to improve staff-student relations. In fact, it is a very cost-effective use of time, rather than a chore to be delegated to electronics.

Inevitably, there are a number of students (usually foreign) whose mathematical foundation is very strong and who have seen (and retained) most of the material previously. The module has copious exercises and materials to remain a challenge to most such students and anyone who requires further work is always invited to discuss it with the tutor. No one has yet taken up this invitation. And no one has yet obtained 100% in this module. In any case, there will always be some students who find most first year courses straightforward.

The Enablers

The Transition Module is a School of Engineering and Applied Science module, compulsory for all first year engineering and mathematics students. Because of the special nature of its aims it is generously supported.

Evidence of Success

In the first few years of presentation the Transition Module dramatically increased pass rates and continues to return respectable pass rates in mathematics and service courses compared to other modules. Because of the detailed initial assessment it is possible to use the examination results to provide a direct measure of added-value in the performance of the students and this has always been substantial.

The Transition Module always receives positive feedback from students and was commended by the Subject Reviews in MSOR and in civil engineering and by various engineering accreditations.

How Can Other Academics Reproduce This?

Many providers already use 'diagnostic tests' to ease the transition to university, some linked to information technology, but may still find some useful ideas in this case study. The probable preparedness data may help them in realistic design of their curriculum and in informing expectations of their staff. Also, it is helpful if the institution can be persuaded that the time that needs to be allocated is necessary and worthwhile for a smooth transition to university.

Quality Assurance

The Transition Module is subject to the same quality procedures as all modules and fares well in that respect. Since it services a large proportion of the first year students in the School there is a wide range of feedback from staff and students.

Other Recommendations

The probable preparedness data obtained in the course of this module, examples of which are given on the website reference, can be used for a variety of purposes, in addition to supporting the module. Some such applications are given on the website and further references included there. In particular, it provides a crude picture of the extent to which entrants retain and can use the skills acquired in their prior education. This is of relevance to the wider debate with schools and FE colleges relating to problem areas in the mathematical knowledge of first year undergraduates.

Reference

School/University Interface – What can Students Do? What Maths Skills do Incoming Students Have?; http://ltsn.mathstore.ac.uk/workshops/maths-support/report.htm#1A; Cox, W.; (13-09-02).

Paper-Based Support

The Maths Revision Booklet as Part of a Programme of Support at University of Newcastle upon Tyne

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Abstract

Computer-based diagnostic testing has been used for new engineering students for some years at University of Newcastle upon Tyne. Follow-up support has been available only in some departments. In summer 2001, new students were issued (in advance or on arrival) with a 'Maths Revision Booklet' covering the basic maths topics that we didn't intend to teach. Following the diagnostic test, lunchtime classes were offered for six weeks, based on the booklet, for those students who wished to attend. We report on the student opinion, analysis of diagnostic and examination performance.

The Execution

A Maths Revision Booklet was issued to new Foundation and First Year Engineering students. Most (64%) received it in advance, following confirmation of offers in August, and the remainder on arrival. This case study focuses principally on First Year students, though Foundation Year students had similar arrangements and used appropriate parts of the same test and booklet.

About 75% of First Year students receiving the booklet in advance also used it before arriving (i.e. about 50% of all students), with a further 25% of all students using it later on. Overall, about 44% of all students used the booklet after arrival. The booklet included number, algebra, trigonometry, graphs, units and dimensions and basic calculus – it covered topics the students were expected to know on arrival and which would not be taught in normal classes. The idea of the booklet, but not its content, was based on the "An Algebra Refresher " produced by Tony Croft at Loughborough (and reported in another of these case-studies).

Diagnostic testing (with DIAGNOSYS) took place in Induction week. From test results and qualifications, some students were recommended to attend lunchtime tutorials. These classes ran for six weeks, and were based on the same booklet.

The normal first year mathematics course of two lectures and one tutorial each week was running in parallel and had a one-hour examination in January counting 20% of the total for this 20-credit module.

Foundation Year students also had access to a DIAGNOSYS back-up booklet on basics of algebra etc. and attended credit-bearing classes; this case-study does not cover this group in detail.

What Support Was Needed?

Diagnostic testing sessions in Induction Week were supervised by a member of staff in each participating department – mostly an administrative job. Test results were collected, printed and distributed by the same staff.

From one to three staff attended lunchtime tutorials twice weekly for six weeks, depending on student numbers, but the intention was that students took responsibility for their own needs, aided by materials and test results. (Foundation Year students receive credit-bearing classes, organised separately.)

The Barriers

- Departments did not all send out workbooks in advance – should be fixed for 2002/3.
- Getting all students to the diagnostic testing sessions is difficult; some students arrive late or are sorting out finance or accommodation. Approximately 80% of First Year students were tested.
- Finding a suitable time for support tutorials is difficult. Lunchtimes were not a popular choice (though we suspect that no time would be universally popular!).

The Enablers

- The 'message' of the booklet and test was that students should take responsibility for their own needs. Some questions did not have answers provided, to emphasise this.
- The demands on staff time were limited.
- Printed materials can be used by students wherever they wish, can be sent in advance and can be used for both self-study and for tutorials. They were also used for summer schools and other purposes. The 'work-book' format makes them easy to use. The cost was about £0.60 per copy, internally duplicated.

Evidence of Success

- Feedback on the materials and classes was generally favourable, though many students thought the diagnostic test understated their actual knowledge.
- 75% of students receiving the booklet in advance used it before arriving. 75% of all students used it at some point. 44% used it after arriving. This is evidence of usefulness in content or in confidence.
- The diagnostic test average for First Years improved this year after a steady but gentle decline (Lawson 1997). Results for 1996-2001 were: 61,60,60,58,56,59%, reflecting some preparation by many students.
- The Semester 1 maths examination results were maintained despite widening intake. Semester 1 exam results for 1996-2001 were: 47,50,54,52,55,53%, suggesting some success in remediation.
- The predictive power of the diagnostic test has reduced, implying a more effective remediation over the first semester, probably partly due to this year's programme. R^2 values for diagnostic mark as a predictor of exam mark for 1999-2001 were: 0.37, 0.28, 0.23 (correlations 0.61, 0.53, 0.48).

How Can Other Academics Reproduce This?

The general policy of setting out clearly to students what we expect of them in respect of knowledge and of responsibility is generic. The workbook is more likely to be used than a text or optional Computer-Aided Learning (CAL) modules, because it is not too long, contains specific and useful content, is easy to organise (finding and using it), can be used anywhere and can be used before arrival, in class or at home. Overall, there are no problems in others using the same approach and our booklet could be used if desired.

Quality Assurance

- The diagnostic test – DIAGNOSYS – is well-established, used in over fifty universities and colleges in the UK and abroad.
- The survey and results gave clear indication of general satisfaction.
- There were no aspects of the maths support that would be expected to affect the normal process of First Year maths teaching, or to increase significantly the burden on participating students. Although some said the lunchtime tutorials were an extra load, these were voluntary and time-limited.

Other Recommendations

- The Revision booklet was largely satisfactory, but will be edited in a few minor points.
- Use of the booklet by sub-A-level students needs to be made clearer.
- Ensuring all new students receive the booklet in advance is important.
- The booklet could also be made available as a document or pdf file on the web.
- More cross-reference between diagnostic test and booklet could be useful.
- Evidence here and elsewhere is that printed support materials are popular if specific, cheap and easy to use. This applies to course notes and some texts also.

Reference

What Can We Expect of 'A' Level Mathematics Students? *Teaching Mathematics and its Applications*, 16(4), Lawson, D. A., (1997).

DIAGNOSYS; hhtp://www.staff.ncl.ac.uk/john.appleby/diagpage/diagindx.htm; (10-10-02).

A Review of the Engineering Maths First Aid Kit and the Algebra Refresher

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Abstract

New support mechanisms have been introduced for Engineering students in their first year at Lancaster University to help maintain standards in all subject areas that are underpinned by Mathematics. Resources that have already been developed by Loughborough University are being used in a slightly modified form to help students to work through and overcome any weakness in Mathematics. Help sheets from Engineering Maths First Aid Kit are used to reinforce student learning. All material is used with the help of tutors to form a good foundation for further studies.

The Execution

The Department of Engineering at Lancaster University has a policy of course assessment that leads to discussion of teaching techniques and the current relevance of course content. Following such an assessment, it was decided to carry out a review of the Mathematics modules common to all the first year students taking Engineering degrees.

Concerns were expressed that standards in Mathematics had been falling for some time, particularly the ability to deal easily with algebraic manipulation. The loss of this particular skill was felt to be causing problems, not only in Mathematics, but also across the full spectrum of Engineering modules. A lowering of standards was not considered to be acceptable, as this would cause problems in the later years of the degree. Finding a method of supporting students with areas of weakness in Mathematics was deemed to be an appropriate way forward.

This support has been put into operation at the beginning of the current academic year, 2001/2002 and consists of support prior to starting at the University and extra resources during the first year of study.

This support is in three parts:

- Prior to starting at the university, a student who has been accepted for an Engineering course with a non A level qualification in Mathematics or who has achieved D or E grades at A level, was sent an adapted copy of 'An Algebra Refresher', the booklet designed by the Mathematics Learning Support Centre of Loughborough University. A letter was sent with this booklet encouraging the student to work through the questions and to contact the tutor concerned with support if problems arose. This was followed by a telephone call by the tutor to all such students to check on progress.
- A diagnostic test is given in the first Mathematics lecture. This is not a multi-choice test as the method of solution is considered to be as important as the correct answer. The questions are designed to contain repeated elements, such as expanding brackets, so that individual areas of weakness can be identified before the end of the first week of study. Any problem areas are explained to the student and help sheets from the 'Engineering Maths First Aid Kit' are supplied in appropriate topics.
- At the end of each week of study, workshops are held for students to work through examples with help from tutors where necessary. The ratio of students to staff gives the opportunity for one-to-one teaching, with help sheets from the 'Engineering Maths First Aid Kit' being offered where the tutors or, more often, the students feel these would be helpful.

Two booklets have been considered for the pre-university support, both developed by Loughborough University.

- 'Foundations of Engineering Maths, a Refresher', contains useful topics other than algebra such as basic trigonometry, logarithms and polar co-ordinates. The format of this booklet leaves very small spaces in which to work and is based on multi-choice answers. The format is felt to be less inviting than that of 'An Algebra Refresher'.
- 'An Algebra Refresher' is not multi-choice and contains many more exercises for the student. The format leaves large, blank spaces which invite the student to write down the working so that this forms part of the booklet; a good technique for revision. As the lack of algebraic skills is the main concern, this booklet is considered to be the correct choice in this case. However, the original booklet contains work that is somewhat beyond the level required and the last two sections, 'Solving Some Polynomial Equations' and 'Partial Fractions', were removed. Both of these topics are taught in the first five weeks of study and for some non A level students these topics are new rather than revision.

The use of the 'Engineering Maths First Aid Kit' has enabled the students to take more decisive action when further practice is needed. The help sheets from this pack have become a popular source of help, not only for students whose Maths is generally weak, but also for those who need help in specific areas. A new help sheet on error bounds had to be hastily produced to meet the requests of students. This will be revised and added to the list for the next academic year. Help sheets on other topics such as differential equations may well be developed in the near future. The help sheets are available at all times from the Engineering Office so that the information is available for other Engineering subjects as well as just for Mathematics.

What Support Was Needed?

The support is being offered to the students by a tutor who has worked in schools and in Further Education. The tutor has specialised in teaching Mathematics to Engineering students for some years and is well aware of the problems that some of the non A level students face. No formal staff training has been given but a copy of the 'Engineering Maths First Aid Kit' has been made available to all tutors involved in teaching first year Engineering courses. The methods of introducing the help sheets from this pack were discussed before the start of the current academic year. There are two tutors involved in the workshops who have many years' experience in both schools and Further Education colleges. The diagnostic test seeks to identify students who are likely to have difficulties with Maths and to put the students into workshop groups led by these two tutors.

The Barriers

One of the barriers to the successful implementation of the pre-university support has been a reluctance on the part of students to ask for help, despite being contacted by telephone. This reluctance is understandable and it may be that a 'Maths First Aid' desk could be made available during the introductory week, giving students the opportunity to talk over problems on a face-to-face basis.

The Enablers

The tutor responsible for introducing the support strategies was also the Maths lecturer for the first five weeks. This gave an opportunity to talk to all the students and explain how to access the available help. As the tutor is based in the Engineering Department, forming good relationships with the students simply by becoming a familiar face with whom to stop and chat on an informal basis was reasonably easily achieved. The tutor teaches in the workshops throughout the year giving continuity of support along with colleagues from the Maths and Engineering Departments.

Evidence of Success

This support strategy is in the first year of implementation. Any evaluation at this stage can only be used as a guide and further verification, or otherwise, must be sought over a much longer period. An attempt to assess the effect of the support has been carried out using two methods.

- A questionnaire was given to the students who received the pre-university support. Approximately 75% of the questionnaires were returned. All of the students who responded stated that they had worked through at least some of the booklet and found this easy to use. There were requests from more than half of the respondents for revision on other topics such as calculus and much the same number that felt an area to 'drop in' for Maths help during the introductory week would have been useful.
- The coursework and tests marked so far this year were compared with the results at the same stage from the previous two years. Comparisons were made between three groups of students over the three years. Group 1 consisted of those students entering the university with non-A level qualifications and D or E grade in Maths at A level, group 2, B or C grade in Maths and group 3, A grade in Maths. The A grade group were separated as this year they have not taken the normal Engineering Maths course but have studied with those students majoring in Maths. This is another form of support, encouraging the 'high flyers' to stretch their natural ability for Maths. Figures comparing last year's groups with this year show little change except for a substantial fall in the average mark for the calculus module in group 1 and a lesser fall in group 2. Other marks remained very similar. The first year students of 1999-2000 achieved much better marks overall than the two later years despite more than half of these students entering the course being in group 1. It is interesting to note that this particular year had a larger than average intake of mature students, many of whom are in this group.

Unless there are significant changes, either for the better or for the worse, the effect of the support may be difficult to assess analytically. There are constant changes to pre-university education as well as in-built variation of students. The final exam marks cannot be compared, as this year's intake has not yet reached that stage, and this may be significant. It is hoped that a clearer picture may be gained by carrying out a full statistical analysis at that time. The subjective impressions of experienced staff may well be needed to supplement any analysis.

How Can Other Academics Reproduce This?

The funding for the materials required for this form of support is very modest. 'An Algebra Refresher' is now available through the Learning Teaching and Support Network (LTSN) in a form that can be produced with the logo of the individual university. 'Engineering Maths First Aid Kit' by Dr. Tony Croft is available from the publishers at a very modest price and there are no photocopying restrictions on the help sheets after that initial cost.

The main cost incurred is through staff time, contacting students prior to the start of their studies. All universities have a tutor or workshop system where familiarisation with the help sheets could be introduced. It is recommended that the help sheets should be kept in an area where students can have easy access to them. It is also important that the staff involved should be approachable.

Quality Assurance

Monitoring of the marks achieved by students over each complete academic year is an objective method of measuring the success of support given. This will be carried out for the current year and for at least the next two or three years.

First year tutors meet regularly to discuss progress and any current problems. This is already used as an opportunity to exchange information about how the new support mechanisms are impacting on other subjects. Although feedback from such meetings tends to be subjective, it is no less valid.

Student comments, both formally through department questionnaires, and informally through constant contact in the relaxed atmosphere of workshops, are noted. The response of students is arguably the best measure of any support strategy.

Other Recommendations

This project is in its infancy and there are several areas that need improvement or expansion, if an appropriate level of funding can be obtained.

- The pre-university support could be offered to all students.
- Materials could be sought or developed in-house that cover other topics in a similar manner to 'An Algebra Refresher'.
- The 'Engineering Maths First Aid Kit' could be used as a model to develop help sheets to cover other topics such as differential equations and statistics.
- A 'drop-in' clinic should be made available during the first few weeks of study. This could be on a very modest scale using one small room and one-to-one teaching. No special equipment needs to be used.
- The culture of support could be extended beyond the first year as the techniques taught are often applied in the later years when further revision is required.
- Early support can help decrease failure and dropout rates. Appropriate investment in this area should pay for itself in successful students.

References

An Algebra Refresher, *LTSN Maths, Stats & OR Network*, Armstrong, P. K., Croft, A. C., Kay, A., Linton, C. M., McIver, M., & Osbaldestin, A. H., (2001), http://ltsn.mathstore.gla.ac.uk/external/

The Engineering Maths First Aid Kit, *Prentice Hall*, Croft, A. C., (2000), ISBN 0130-87430-2.

Computer-Based Support

Changing Courseware with Diagnostic Testing

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Abstract

The Mathematics Department at Keele University has pioneered the use of diagnostic testing linked to Computer-Based Learning (CBL) self study modules for students entering Principal Mathematics. In particular, the department has invested in the use of Mathwise modules to provide support materials. Recent advances in software have produced a new generation of courseware but there is considerable inertia in changing to such new material without some evidence that students will benefit. This case study considers this problem and considers how diagnostic testing can be used to decide when to update the courseware being used.

The Execution

The Mathematics Department at Keele University has been using computer based diagnostic testing since 1997 in an attempt to identify any mathematical weaknesses in students entering Principal Mathematics. At the end of the diagnostic test each student is presented with their own skill profile, and a suggested individualized programme of work which is relevant to the results of the diagnostic test, see **http://www.keele.ac.uk/depts/ma/diagnostic/**

The primary aim of this process was to identify individual students' mathematical weaknesses and provide support at the earliest opportunity, and in particular to identify students who struggle as soon they meet their peer group for the first time. The results of the diagnostic test are collated and made available to departmental tutors when they meet their assigned tutees. This provides valuable information and yet requires minimal staff resources.

Since 1998, students have been "expected" to use Mathwise modules, to remedy any skill deficiencies. At the end of the diagnostic test students are asked if they believed the results were accurate. The vast majority agreed with the results and thought they were a fair reflection of their current capabilities. Students were also asked if they would follow up the suggested programme of work and the response immediately after the diagnostic test was positive.

Students were interviewed again several weeks later and it was found that less than 30% had completed the work suggested. The major difficulties listed, in addition to the time required to complete the work required for their lecture courses, were the limited number of examples available, difficulties inputting expressions and the lack of any computer algebra behind the package.

Over the last three years there has been substantial development in courseware. The department considered several such packages to replace or supplement Mathwise, but although systems such as Mathematica and Maple are excellent tools for doing mathematics they are a little less useful in a teaching context as they do not reveal the processes by which they solve mathematical problems. A new computer algebra system, called Calculus Machina, which is able to evaluate many of the derivatives and integrals students are likely to meet in first year mathematics but is also able to document the steps by which such problems are evaluated, was proposed as an alternative. (See **http://ltsn.mathstore.ac.uk/articles/maths-caa-series/nov2001/index.htm**)

Before switching to Calculus Machina, with all the upheaval this could cause, it was decided to run a comparative study. The students studying Principal Mathematics during the academic year 2000-2001, were divided into three groups. Those scoring in excess of 65% on the diagnostic test were deemed to have a satisfactory understanding of the material normally expected and were asked to look at a Mathwise Module: Applications of Differentiation. The remaining students were randomly sub-divided into two groups (B1 and B2). Group B1 was asked to study a Mathwise Module: Rules of Differentiation and Group B2 was asked to use Calculus Machina in order to improve their basic skills in differentiation. The aim of the study was to compare the performance of groups B1 and B2. To do this groups B1 and B2 were asked to retake the diagnostic test after studying their assigned material and also complete a paper-based questionnaire.

What Support Was Needed?

Both Mathwise and Calculus Machina have been designed to be used in a self-study mode and so little additional help was needed beyond preparing a one-page handout to get students started. (None of the students had seen either courseware previously.) Little additional staffing was required.

The Enablers

All students entering mathematics are required to take the diagnostic test and are encouraged to use the programme of study it produces. The staff in the department have been very supportive and have actively promoted its use.

Evidence of Success

To validate the diagnostic test results, all students in the 2000-2001 cohort were also asked to take a written test requiring

them to evaluate a number of derivatives. A statistical comparison of the written and diagnostic test showed that the scores were highly correlated (r=0.75, p<0.001) and that a simple linear regression model accounted for 55% of the variation of the marks.

A total of 28 students completed the pre and post-diagnostic test though somewhat fewer also completed questionnaires. The students in Group B1 had a mean baseline score of 49.53 whilst those in Group B1 scored slightly less, 43.3, though this difference was not significant, (p=0.23 using a t-test). Two students in Group B2 were not included in the analysis, as they would have skewed the result even further in favour of the Calculus Machina. (One student scored 1 in the pre-test and 68 in the post test, the other 8 and 40 respectively, and it was felt that these would skew the data in both absolute and relative terms.) To investigate the effectiveness of the packages allocated to the two groups, the mean paired absolute differences of the two groups were analysed.

The results of this trial are given below, and suggest that Group B2 have improved significantly more than B1 (p=0.005) even though their pre-test score was slightly poorer. Analysing the relative improvement in diagnostic score after using the software gives a similar result. Even though there is substantial variation in the results observed and the sample sizes are relatively small we can conclude that, based on these results, the Calculus Machina appears to be the more effective software when used in this context.

It must be noted that a direct comparison between Calculus Machina and Mathwise: Rules Of Differentiation is a little unfair as they are several generations of software apart and the Calculus Machina is designed to include algebraic skills that enable students to enter their own problems. Furthermore, the sample sizes are relatively small. However, a similar experiment was conducted during the academic year 2001-2002 and the results were very similar.

Although the study considered only differentiation a substantial number of students have requested that it be extended to cover integration. The departmental learning and teaching committee has agreed to run a pilot project in 2002-2003. The results will be published when available.

Questionnaire Results

Eighteen completed questionnaires were returned; 9 from group B1 and 9 from group B2. Respondents reported a wide range of reasons for studying Mathematics or Statistics and a wide variety of topics in which they had perceived strengths and weaknesses. Nearly all of the students regarded the diagnostic test as accurate. Students varied widely in their attitudes to computer use and their views on computer-based learning.

Some appreciated the fact that the computer allows them to work at their own pace, provides instant feedback, and leads them step-by-step through methods; others found the experience somewhat stressful.

How Can Other Academic Staff Reproduce the Study?

All the material is readily available.

- Diagnostic Test.

Available at **http://www.keele.ac.uk/depts/ma/diagnostic/** together with case studies and information on other diagnostic tests. The diagnostic test used at Keele was written by Stephen Hibberd and Stephen Brydges, (Nottingham University) and modified to the requirements of Keele University in consultation with staff at Keele. Contact the author for further details at **d.a.quinney@keele.ac.uk**

- Computer Based Modules.

Mathwise units Concepts of Differentiation, Rules of Differentiation, Applications of Differentiation. All modules are available on the TLTP CD circulated freely to all departments at UK universities. Contact the LTSN Maths, Stats and OR Network for further details.

- Computer Algebra System

Calculus Machina, John Wiley, 2002. Available to students and staff via the WWW at $20/year.
www.wiley.com\college\machina

Other Recommendations

- The Mathematics Department has used a simple diagnostic test for some years as a means of differentiated teaching and support for students. This project has now verified that the use of the diagnostic test provides a simple cost-effective means of identifying student weaknesses in the skills associated with differentiation.
- Calculus Machina has been shown to be more effective in renforcing the skills associated with basic differentiation. Accordingly we aim to build it into the week that the department has set aside for developing the students' skills in Introductory Calculus from the academic year 2002-2003. Existing technology and courseware is available to help detect areas of mathematical weakness at individual student level. Although discussions with course tutorial support staff are vital, the computer-based profiles provide a pro-active mechanism for the early identification of student weaknesses. The basis of this paradigm is dependent on the development of study skills by individual students and the inclusion of both summative and formative assessment can help reinforce this.

Table 1

Results of the Trial

Group	B1	B2
Number	13	13
Software	Mathwise	Machina
Pre-test score	49.53	43.30
SD	14.61	10.94
Mean Difference	5.38	22.4
SD	10.39	17.02

A Review of Student Support Computer Packages used in Universities

MATHWISE Pre-Calculus

Interview with Sanowar Khan ▪ School of Engineering ▪ City University, London

Background

At City University, a number of first year engineering students are using the software package Mathwise Pre-Calculus. The degree programmes such as BSc/BEng Electrical and Electronic Engineering, BSc/BEng Computer Systems Engineering and BEng Multimedia and Internet Systems contain students with varying backgrounds, some of whom have low A-level grades in mathematics or with no A-level mathematics.

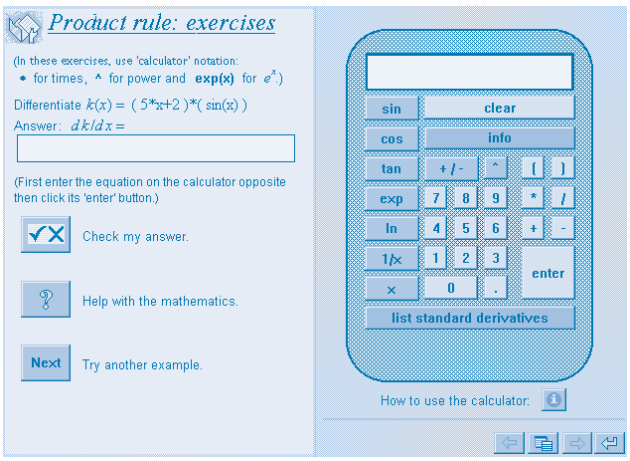
Integrated within the module General Mathematics, the package is intended to provide lecture support, offer an interactive learning option, improve student understanding and enhance self-learning habits.

The Execution

The package is incorporated into a weekly four-hour teaching slot, over a period of 20 weeks. Three hours of this is lectures with a one-hour tutorial that is not compulsory but provides assistance for students. Within the three-hour lecture, one hour is set aside for a tutorial in Mathwise.

During timetabled sessions the students work individually or in pairs. The package is also available for use on home PCs for self-study. This provides the student with the opportunity to work through the material at his or her own pace. At this stage it is not part of the assessment process.

At City University, Computer Assisted Learning (CAL) and Computer Based Learning (CBL) are considered important add-ons to the delivery of lecture material. Funding is available for such tools and lecturers are encouraged to make use of them.



Product rule exercise from Mathwise Calculus Cluster

Staff Perspective

Responses from the academic interviewed were positive. The general approach to teaching and presenting the material was considered appropriate for the subject matter and the students. The hierarchical structure of the package was easy to follow; it offered students the opportunity to engage interactively, investigating different variations and observing the effects. Altogether, it was found to be a powerful conceptual tool, which encouraged the student to learn through interactive elements, animated graphics and self-assessment exercises.

Student Perspective

Integrated within the lecture and tutorial sessions, six students completed a questionnaire based on use of Mathwise Pre-Calculus. It was viewed as a valuable source of mathematical learning. Many utilised the university facilities to access the package; some downloaded the software onto their laptops or PCs for home use.

The package fitted well into the rest of the course, and was easy to use. The students felt that the material was presented in a logical order. Frequent use was made of the on-line help; each used the self-test questions and the marked questions. The students did however request more information regarding their progress and performance when exiting the programme.

Comments were extremely positive; for example one student made the following statement; “We had theoretical knowledge only. Mathwise showed many of the practical applications. It helped us to confirm our doubts. (I mean if we had any doubts, say …about a graph…we were able to confirm the correct shape)…etc. It made the subject interesting and helped us to broaden our knowledge in Mathematics. It was very useful”.

There was however a contrasting viewpoint that possibly highlights the need for packages such as Mathwise, to teach diverse backgrounds.

“For those students who are in the low level it can be very useful, but for me I found it very, very, very easy, then I was bored doing it.”

CALMAT

Interview with Dexter Booth ▪ School of Computing and Engineering ▪ University of Huddersfield

Background

The School of Computing and Mathematics at the University of Huddersfield offers the first year module, Mathematics 1. Delivered over two semesters the course consists of 12 teaching weeks. Each week the course material is demonstrated in two one-hour lectures, which is followed up by a computer mediated one-hour tutorial coupled with more than five hours of directed unsupervised activity. The module aims to provide a solid foundation of skills in using mathematical techniques and an awareness of a range of mathematical techniques for analysis and modelling for engineering.

Approximately 120 MEng and BEng students enrolled in Electrical and Mechanical Engineering courses participate in the module, a comprehensive syllabus in which the software package CALMAT plays an important role. An assessment suite called TASMAT accompanies the software (Tutorial and Assessment in Mathematics).

The Execution

CALMAT was integrated into the module five years ago. The content of each lecture was related to one of the CALMAT modules and the appropriate course notes were duplicated. Each tutorial was taken in a computer laboratory and also related to one of the CALMAT modules.

Certain other modules were designated as 'starred' modules and the student was expected to work through these in their own time. These formed the directed unsupervised activity (DUA). Every three weeks the students sat a TASMAT test during the appropriate tutorial.

The assessment of the module is in two parts; the in-course assessment (40%) and the final examination (60%). The in-course assessment is built up by collecting points. The seven TASMAT tests contribute a maximum of 40 points. The first test will contribute a maximum of 4 points and the remaining six tests will each contribute a maximum of 6 points to the final grade.

To encourage the students to take part in their directed unsupervised activity and so develop their own self-assessment, each completed 'starred' modules gained them an extra point. There are 15 of these self-assessment programmes. These extra points can be added to their test points to accumulate to a maximum of 40 points.

Staff Perspective

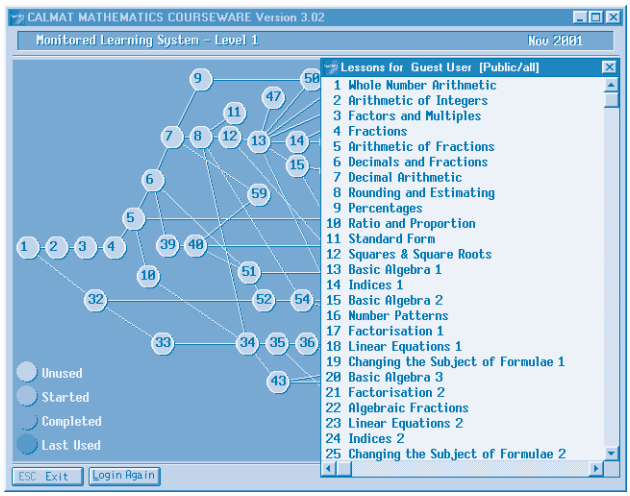
The CALMAT interface was described in the interview with the academic as interactive and straightforward, covering all general topics from foundations of arithmetic, through trigonometry to complex numbers.

It was observed that by embedding CALMAT within the module, the learning culture of the module changed. The software provided an educational tool for the student, which did not exist before. In linking the package with the assessment procedure this seemed to create a willingness for the student to participate. The software became in many cases an enabler for the student to progress in the module (This effect had also been observed in a bridging course, run in the summer for students applying for computing courses).

Student Perspective

Comments from six students presented an element of enthusiasm towards using the package. There was a clear understanding of the practical tools available, e.g. the assessment mode, the on-line help, tutorials and questions. One student stated "it provided practice for exam questions and lots of different questions on the same topic".

The shift from the paper-based tutorial to software embedded within the module had enabled the students to put in a consistent effort throughout the year. Regular effort was made to practise questions and revise, and this contributed to a more structured approach to learning and a genuine understanding of the mathematical topics.



Module map from CALMAT

Web Based Support

Coventry University's Mathematics Support Centre's Website

Duncan Lawson ▪ School of Mathematical and Information Sciences ▪ Coventry University

Abstract

The Mathematics Support Centre at Coventry University (originally known as the BP Maths Centre) was established in 1991. The Centre aims to provide early identification of problems and on-going support for individual students. This is achieved through use of diagnostic testing, the provision of a wide range of resources and the availability of one-to-one assistance on drop-in basis. The Centre's website was launched in September 2000 to:

- *extend the support provision to students who did not find it easy to visit the Centre (e.g. part-time students);*
- *provide access to a range of resources at times when the Centre is closed;*
- *deliver new support activities such as online practice tests and email questions.*

The Execution

The Mathematics Support Centre at Coventry University (originally known as the BP Maths Centre) was established in 1991 with a grant from BP's Engineering Education Fund. The original aim of the Centre was to offer support in mathematics to engineering undergraduates through the early identification of problems and the provision of on-going help. This was to be achieved through the use of initial diagnostic testing and the availability of one-to-one assistance on a drop-in basis.

Initially the Centre had a full-time manager who oversaw the development of the service provided by the Centre. However, when the BP funding and subsequent short-term University funding ended, management of the Centre was taken over by the current Director as one of his many duties as a lecturer within the Mathematics Subject Group. The Centre continued to provide valued support to a range of students and was frequently praised by external organisations such as Professional Body Accreditation Panels and QAA Subject Review teams.

When the University published its Teaching and Learning Strategy in 1999, the work of the Centre was recognised and it was specifically mentioned as a key agent of student support. This led to the University providing funding for the work of the Centre. This funding allowed the Centre to employ a Mathematics Tutor to be responsible for the day-to-day operation of the Centre and to carry out new initiatives to enhance the support provided.

One of the new initiatives implemented by the Mathematics Tutor was the development of the Centre's website. This was launched in September 2000. Originally the site contained pages giving basic information about the Centre such as its location, opening hours, a description of the support available, a range of downloadable handouts, a number of self assessment practice tests and a facility to email questions to the Mathematics Tutor. Since then the resources on the website have been expanded, primarily in range (more handouts and more on-line tests have been made available) and also in scope. For example, originally there was one on-line test per topic; this has now been extended so that questions are randomly selected from a bank so that a student can take a practice test more than once and be given different questions each time. In addition, a number of short 'multi-media' presentations of basic topics (such as multiplying out brackets and solving linear equations) have been added. These presentations consist of user controlled multi-step animated demonstrations of an activity with a sound commentary at each step.

What Support Was Needed?

The financial support provided initially by BP was beneficial in starting the Centre. When this funding ending the Centre operated successfully for a number of years essentially through the goodwill of lecturers who gave an hour or two each week to staff the Centre. The central funding the Centre now receives has made initiatives like the website possible.

Development of the website has required technical support which has been provided by one of the School of Mathematical and Information Sciences Development Officers. The Mathematics Tutor provides the content and the Development Officer uploads it to the website. Most of this is routine website maintenance, however the Development Officer has implemented the on-line practice tests by writing a number of PERL scripts to randomly generate the tests from a bank of questions and to process the students' answers giving feedback when the answers are incorrect.

The multi-media presentations were produced in association with the University's Teaching and Learning Support Unit who provided expertise in the use of Flash. Training in the use of Flash is shortly to be provided within the School and, following this, the capability will exist within the School to develop more of these items.

The Barriers and The Enablers

There are two main barriers to the success of the website:

- knowledge of its existence;
- motivation to use it.

The first barrier is addressed by a widespread publicity campaign during induction week. When the website was first launched, the Centre hosted an open afternoon just prior to induction week to which all academic staff were invited. In addition to the general invitation issued to all staff, individual invitations were sent to course tutors from courses with substantial mathematical, statistical or quantitative methods elements. As part of their induction week programmes, many students visit the Centre. During this visit they are given a short talk about the support the Centre provides (which includes reference to the website) and they are given a formula sheet which states the Centre's opening hours and gives the website URL. The University has adopted the virtual learning environment WebCT. Every module has its own WebCT web containing a number of standard items and a number of customisable ones. One of the standard items is a set of links to generic learning resources such as the library's website. One of these links is to the Centre's website.

The second barrier of student motivation is considerably more difficult to overcome. From monitoring usage statistics, it appears that the on-line practice examples are highly valued by the students. For this reason, considerable effort has been devoted to expanding the range of topics covered by these tests and increasing the size of the question banks so that students can take more than one practice test on a given topic.

Evidence of Success

The primary evidence of success is the number of hits the site receives. These statistics indicate a general upward trend (although there is some variation throughout the year) in the amount that the website is used. No formal mechanisms have been used for gaining student feedback about the website although it is planned to make an on-line questionnaire available.

How Can Other Academics Reproduce This?

The website is only one part of the wide ranging support provided by Coventry University Mathematics Support Centre. Whilst setting up a website to make resources available electronically is reasonably straightforward, if this is done in isolation it may not provide a great deal of benefit to students. The website needs to be part of a larger support provision.

A significant amount of time is required to develop resources to be delivered by the website. Institutions may already have some handouts available in hardcopy form and these can be delivered over the web if electronic versions of them exist. The provision of online practice tests requires the time of an academic member of staff to develop suitable questions and then technical support to develop the infrastructure to deliver them over the web.

Quality Assurance

There is no formal quality assurance of the Centre website. The Centre itself is subject to occasional monitoring by the University and is scrutinised by outside organisations such as the QAA and a range of professional bodies. Colleagues from other institutions have commented on the website following demonstrations at conferences and workshops both in the UK and abroad.

Other Recommendations

Given the current pressures on academic staff time it is essential that duplication of effort is avoided. One way of doing this is through the sharing of resources. Access to the resources of the Centre's website will be given to other institutions if mutually beneficial arrangements can be made. Anyone interested in exploring possibilities in this regard should contact the author (preferably by email: **d.lawson@coventry.ac.uk**).

Reference

A Web-Site for a Mathematics Support Centre. In *Technology in Mathematics Teaching*, M. Borovcnik, M. & Kautschitsch, H., (Eds.). Vienna, Austria: hpt & oebv, Lawson, D. A., Reed, J., & Tyrrell, S. E., (2002).

MathinSite: Maths Insight from a Maths Website

Peter Edwards ▪ Department of Design, Engineering & Computing ▪ Bournemouth University

Abstract

During the early 1990s, mathematics software was written using Visual Basic for students at Bournemouth University. With the advent of the Java programming language, this software was translated and extended into MathinSite, a website containing mathematics applets (small programs that can be run through a web browser). The primary aim of these applets is to help deepen mathematical insight through dynamic, interactive visualisations. Use of the Internet not only ensures that the content can be delivered within a student's own educational surroundings, but also that any user can access the content any time of day or night from any computer in the world with an Internet connection.

The Execution

In the early 1980s, the author, armed with a BBC Model B computer, wrote some BBC Basic software presenting graphical visualisations of Mass/Spring/Damper Systems, Projectiles and a CNC Lathe Cutting Simulation. These visualisations all proved popular with students; the latter, in particular, proved popular with UK Local Education Authorities since the software allowed students to use a computer visualisation to validate their CNC lathe programs before committing them to expensive CNC machinery! The arrival of event-driven programming languages, Visual Basic in particular, allowed the author to enhance this graphical approach to include the use of scrollbars to change system parameters, obviating the need for textual input. To see, for example, how a Mass/Spring/Damper System's response changed in real-time as the system's parameters changed fascinated students and encouraged inquisitiveness and a willingness to learn. When using the Exponential Equation program, for example, written to investigate $y = A + Be^{kt}$, students could be heard exclaiming, "Oh, is that what k does!", as they changed the value of k using a scrollbar. At the time, the author had problems delivering such software over his university's network. The advent of the Java programming language, however, opened up the possibility of Internet delivery so, with the award of one of Bournemouth University's Learning and Teaching Initiative bursaries and the help of a Computer Studies placement student, MathinSite was begun.

To date, a variety of Java applets have been written. The applets' topics have, necessarily, been restricted to mathematical applications that

- can be visualised,
- depend upon the variation of parameter values, or similar, to enhance the visualisation and hence deepen the user's understanding and
- are relevant to the author and his own Design and Engineering undergraduates.

Applets included so far range from simple mathematical functions up to complicated engineering applications of mathematics, such as dynamically illustrating how the stability of a second-order system is governed by the position of the system's poles in the complex *s*-plane.

Considering MathinSite's applets in isolation should be avoided. For example, the 'Differentiation 1' applet consists only of the well-used – possibly over used – graph of $y = x^2$ and two movable points on the curve together with their associated 'rise' and 'run' lines. Just using the applet, users will not necessarily understand anything. However, when used with the associated worksheet it is possible to take users through the meaning of chords and tangents. It would be superfluous to force this applet to do the same with the graph of any other function. The separate 'Differentiation 2' applet, however, does show the graphs (and first- and second-derivative graphs) of other functions. However, the main thrust of 'Differentiation 2' is to use the applet's graphics and worksheets this time to promote a good understanding of the concepts of gradient, curvature and stationary points.

What Support Was Needed?

The applets are simple to use since the only user-interaction is via scrollbars or by 'dragging' with the mouse in the graphics area. Any student who is familiar with the 'Windows' environment will be able to operate the applets within seconds. Unlike graphical calculators and computer algebra packages, MathinSite's mathematics is readily accessible and does not necessitate a serious learning curve just to reach the usable content. When using the applets on their own, it is not always possible for students to make the connection between the on-screen movements and the underlying mathematics. In order to make these connections, students are encouraged to use, at least initially, the worksheets that accompany each applet. These take students 'by the hand' and help them to discover aspects of mathematical understanding that are not easy to grasp from a static diagram in a book. Since the amount of on-screen text is kept to an absolute minimum, students cannot be distracted by unnecessary tutorial type screed whilst interacting with the applet – any tutorial text is on the separate, paper copy, tutorial and theory sheets. Armed with the worksheets, students do not need the help of any tutor to engage with MathinSite's content – MathinSite is self-supporting.

The Barriers

Some students do not buy textbooks. Some students miss lectures. Some do not read course notes. And some students don't like interacting with computers. It appears as though whatever students are given to help them learn and understand course material, some of the help will not work for some of the students. So it is with MathinSite. Students are told of the availability of this resource, but some avoid its use – often because other factors are deemed more important, such as assignment work (although there will be occasions where the applets will help corroborate answers to assignment questions undertaken manually).

The Enablers

Tutorials are a valuable way of introducing students to MathinSite. Once students have seen MathinSite in action and realise how valuable it can be, they are quite willing to investigate further applets on their own. However, it is not always possible to book computer rooms for a one-off MathinSite tutorial so, for some student groups, this introduction is not possible. Instead, using it at relevant junctures during lectures becomes highly appropriate – not just for demonstrating a mathematical point, but also to remind students of its existence. Obviously if MathinSite's use were to be assessed and marked, this would force students to use this resource, but there are no immediate plans to do this. MathinSite is not specifically intended to help directly with assignments; its main success to date has been in deepening understanding, giving students a feel for mathematics and helping students to engage with mathematics.

Evidence of Success

That many students do use MathinSite is evidenced by subsequent comments on what they have learned and by asking the question, "When are you going to write an applet on…?". Particularly gratifying are oft-heard comments of the type, "I never realised, before using the applet, that changing that parameter had that effect". In terms of national and international usage, MathinSite's hit-rate soared when the website was placed on an American Java Resource site. A web search for MathinSite on a variety of Internet search engines reveals that it is now listed on mathematics resource web pages in many countries. One email to MathinSite, from the Assistant Director of a Mathematics Education Centre at an American university, mentioned "Wonderful stuff!" and was recommending its use to all his students.

How Can Other Academics Reproduce This?

Other academics need not reproduce this particular resource since it is freely available for all to use. However, the approach adopted here could easily be applied to other disciplines where a graphical interpretation can enhance learning and understanding. The drawback is that the production of Java applets needs programming skills and can be very time-consuming, as can the production of the accompanying worksheets. Certainly, without the funding from Bournemouth University's Learning & Teaching Initiative and further funding from the UK National Teaching Fellowship Scheme (NTFS), MathinSite would still be at the design phase.

Quality Assurance

At the time of writing (March, 2002), most of the work on MathinSite has involved writing and releasing as many applets as possible. Because of this, the production of worksheets has had to take second place. Each applet as it comes on-stream is tested with a not-inconsequential group of critics – students! As well as local face-to-face discussion with end-users, MathinSite facilitates basic feedback from its own web pages. Up to the present, there have been no adverse comments. Any 'negative' feedback has been to correct minor errors or to suggest ways of enhancing individual applets. The NTFS funding for the project will allow continued production of material to 2003, in particular to write the outstanding worksheets. Also during the 2002 – 2003 academic session, it is proposed to incorporate a web-based feedback form on MathinSite and to visit a variety of UK educational establishments to explain and promote its use.

Other Recommendations

MathinSite started out nearly 20 years ago as a hobby – a mathematics lecturer wanting both to improve his programming skills and to help his students to visualise mathematics. It had to wait most of the 20 years for the right technology, and funding, to come along to turn it into a worldwide resource. Without 'enthusiastic amateur' beginnings, such projects rarely come to fruition. Once a concept has been proven, however, it becomes easier to attract funding, which then facilitates buying out one's time, or buying in the services of others. So far during the production of MathinSite, the author has been most fortunate to employ two excellent Computer Studies students, out on their placement year, who have been used to very good effect in writing applets. Along the way the author has also bought time out to produce some applets himself, and to endeavour to write up the backlog of tutorial sheets.

Anyone starting such a project should therefore consider the following:

- Don't wait for someone to provide funding. If you have a good idea, try to develop it in any time you have available.
- Sell the idea to your own university or college. Your institution's Learning and Teaching Resources Centre, in particular, may know of, or may help you to attract, available funding.
- Funding, if you can get hold of it, gives you greater flexibility in deciding how your project's development should proceed.
- Make sure you have a realistic project plan – particularly, what you want to achieve and by when.
- (The right) Industrial placement students can be a very valuable resource.
- Dissemination is vital. The use of MathinSite blossomed once information about it was placed strategically on Java and Mathematics resources websites. Publications and conferences are also invaluable for maximising your project's coverage within your own academic community.
- Try to draw in your own colleagues for help, support and feedback – and as a valuable quality assurance resource.
- Don't forget to involve your students. Students are not shy when they want to tell you something is good – or not!

Reference

MathinSite: Web-Based Material for Deepening the Mathematical Insight of Engineering Undergraduates. Paper presented at the ASEE/SEFI/TUB Colloquium, Berlin, Germany, Edwards, P., (2001), http://www.asee.org/conferences/international/proceedings/Edwards.pdf

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