MATHEMATICS SUPPORT *Newsletter*

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Conference on Mathematics Support in FE and HE

The issue of students' lack of numeracy skills and apprehensiveness about taking mathematics and statistics as part of their studies occurs each year in FE and HE. We plan to get together in a 'grass roots' conference on Thursday, 14 September.

The various aims of the conference are to:

- inform ourselves of the variety of maths support
- present some of the best practice in FE and also HE in the UK and introduce some recent innovations
- produce a book on maths support material and lists of users with case studies of applications
- provide a place where we can meet others working in our area
- present current research efforts and plans
- look at our work within the wider picture of the changes in our education system and attempt to predict the changes on the horizon.

Given these aims, it seems sensible that the greater part of this conference engages in small group discussions sharing examples of best practice in each type of support. Keynote speeches will take a broader view of our work, the educational system and institutional issues.

(Details on pages 22-23)

The Changing Mathematical Background of Undergraduate Engineers

A Review of The Issues: Drs. Rosamund Sutherland and Stefano Pozzi, March 1995, University of London Institute of Education.

Everyone who teaches maths or numerate subjects should read this report. Although focused on engineering students, its findings and the wider issues raised have considerable implications for the delivery of QM, Statistics, Numeracy and Maths units.

The research looks at the mathematical demands of engineering programmes and their teachers, and at the content and approach of pre-university mathematics courses.

Particularly interesting is the focus on change; too many of those concerned with mathematics are reluctant to admit the existence, never mind the inevitability, of changes in the curriculum, and the need for a new look at how mathematical ideas are acquired and used.

This report looks at the changes we can expect from the growth of computer-based learning and questions the wisdom of unevaluated use of self-learning maths packages.

At a time of increasing student numbers these can seem to provide an easy technological fix for the very real complexities of teaching our subject to students with very varied backgrounds.

Perhaps the clearest voice to emerge from the report was that of the students; their familiar cries for help reflect the continuing domination of chalk and (lecturer) talk.

> *Postgrads. are given the solutions written out by the maths lecturer, and then when you have problems you go to the postgrad. and they run through the solutions but they don't explain... so people would queue up and wait for the lecturer and, of course, the lecturer never got round (to all of the students) so that's why people wouldn't attend tutorials very much. (p 30-31)*

As well as providing many pointers for new research, and some for course development, this work provides some welcome data in the ongoing slanging match about falling standards.

Ros Sutherland will be one of the keynote speakers at our conference. If you plan to attend, we urge you to read this work.

- *The report can be obtained by sending an A4 SAE (76p) to: The Engineering Council, 10 Maltravers St., WC2 3ER.*

Sybil Cock, University of North London.

see back page for contents of this issue

Newcastle College Workshop

Introduction

The maths workshop is located within the Faculty of Humanities, Hospitality and Science at Newcastle College and has been up and running for five years. It is one of six curriculum workshops in the college.

It is open from 9:00-5:00 during the day with support from the Curriculum Information Officer who is responsible for the workshop during the day and on two evenings when there are maths evening classes the teaching member of staff is responsible for the workshop.

The workshop is organised by a Curriculum Information Officer (CIO) who is part of the Learning Resources Service of the college. This person does not teach but is there to see that the students get the maximum benefit from the workshop by maintaining the pleasant environment and ensuring the materials and equipment are prepared and are easily and constantly available. This is done by setting up simple systems.

The CIO is a link between the students, their work and the lecturer. The CIO attends meetings in both the Learning Resources Service and in the Maths section so that there is a free and regular updating of information and ideas.

Planning the environment

The first thing a person notices about the workshop is its pleasant physical and working atmosphere. The room is large and rectangular in shape, airy, with seats for about 60 students. The furniture is in good condition with comfortable padded seating and is set out in an informal pattern i.e. in 'islands' of two or three tables together, but also there are some single tables set aside.

This enables students, if they choose, to work in small groups of about four or five or to work by themselves. There is also a small tutorial room attached to the workshop so that private sessions can be held, or small impromptu classes, or the students can watch videos or listen to audio cassette tapes.

Mainstreaming the workshop

The workshop is class based i.e. during every session in the workshop there is a lecturer present. However, if a student needs help or wants to do some extra work and there is room in the workshop, then the student is welcome on a drop-in basis. The materials are always available and the CIO is there to help direct the student to the relevant material.

Although the lecturer's responsibility is to his/her class, usually the lecturer can time to deal with a query. We encourage students to make as much use as possible of the workshop and emphasise the flexible approach we have.

As there is always a responsible person available in the workshop then students, if they wish, can leave work to be marked at any time and at the same time pick up the next piece of work. At lunch times there is maths study support where a lecturer is specifically designated to the drop-in students.

A-level maths students have formal maths lessons and also have separate study support lessons. These study support lessons are held in the maths workshop where the students have access to the whole range of materials we hold, and also lecturer support.

Open Learning materials

The material used in the workshop is paper based. We use the Bradford Units purchased from Bradford and Ilkley Community College and the Kent Mathematics Project published by Ward Lock Educational Co. Ltd., East Grinstead, Sussex, adapted with their special and kind permission for GCSE work.

The college subscribes to the Further Education National Consortium and uses the Pure Maths and Statistics Units for A-level maths work. There are also some in-house maths packages for foundation maths which are available.

The material is openly shelved and is easily accessible for staff and students. The students have a work schedule which is designed by the lecturers and maintained by the CIO, and is displayed so that students can continue to work without interruption and at their own pace. This means that students can join the maths system at any time although we are still governed by the national GCSE examination timetables.

Computer resources

The college has an IT drop-in facility and a separate IT centre for the teaching of IT. It is hoped to have a small network of computers dedicated to maths in the workshop.

Managing the workshop

The workshop has a good working atmosphere. It is not library-quiet as there is a constant hum of activity. There is always a lecturer present to help and the informal layout lends itself to peer group help which is always valuable in the learning environment.

Discipline in the workshop is not often a great problem because; (i) the students are there by choice, (ii) there is always a member of staff present and, (iii) it has a manager.

Running the workshop is not cheap. The cost of reproducing the materials is expensive and has its own logistical problems because of the scale of the operation. The college has a central Reprographic Service. Maintaining the level of materials is almost a full-time job in itself. The materials need to be sorted, organised and labelled.

We are constantly looking for new materials so that there is a greater range available for the students. The staff are always creating new ways of presenting the maths material to try to make the topics easier to understand and, in a way, easier for the student to assimilate .

> 'the retention rate has significantly increased by using workshops'

The college has a Learning Materials Service where learning packages written by members of staff are developed from the raw state of rough notes to a finished, well laid out package. The college has a 'house style' and standard layout for these packages which makes them easily recognisable as learning packages for the student.

Each of the curriculum workshops holds its own class sets of specialist learning packages and the college library holds copies of them on short loan so that they are available college-wide and all the time.

At the same time if a learning package is appropriate in other workshops then it is made available. Similarly, as maths is a topic universal to all the faculties in the college the Bradford Units are held by all the workshops. The college library also has a range of maths text books to supplement the paper based material.

Tutoring

The lecturers present in the workshop need to be very flexible because they might be asked about anything (usually mathematical but not always) from very basic maths to degree level.

The staff in the workshop are helpful and try to accommodate the students' needs as best they can. We find that mature students who are anxious about learning mathematics or returning to study really enjoy the working environment. Here they can learn at their own pace with all the help they require. On the other side of the coin, younger students, perhaps straight from a strict classroom environment in school, can find the complete freedom too much on occasion. Such students need careful guidance in their first few weeks in the workshop.

Evaluation and conclusions

The results at GCSE level indicate that whilst the pass rate has remained at a constant level, the retention rate has significantly increased by using workshops. We have found the advantage of using a workshop is that peer-group help increases the retention rate.

The flexibility for students to work at their own pace within the examination timetables has enhanced the learning experience for students at Newcastle College. It is very pleasing to find that students from other faculties or curriculum areas come into the workshop, saying that they have heard from fellow students what a pleasant place it is to work in.

We do our best!

by Val Allport (Maths Workshop Co-ordinator), Mark Lakeway (Director of Learning Resources), Allen Armsby, Joanne Casey: Newcastle College Faculty of Humanities, Hospitality and Science Mathematics Workshop

MATHEMATICS

SUPPORT

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The next issue will be Christmas 1995 which is planned to include conference proceedings.

The deadline for contributions for inclusion in the next issue is October 30, 1995.

Workshops in New Universities

Mathematics Advice Centre at Middlesex

The Mathematics Advice Centre (MAC) at Middlesex University was formed at the beginning of 1993/94 academic year to serve the following purposes:

- To diagnose students' difficulties in mathematics and give appropriate advice
- To identify the common problem areas encountered by students in their study of mathematics and facilitate their resolution
- To note the views and opinions of students about learning mathematics and channel them to appropriate members of staff
- To encourage students who lack confidence in mathematics
- To promote mathematics and the School of Mathematics' standing amongst students

The centre was initially promoted via two articles in the University's official newspapers. In writing the articles every effort was made to portray the centre as a place with a serious purpose but a friendly atmosphere where no problem is considered to be too trivial or too small to be asked.

In order to make sure that no stigma would be attached to using the centre, MAC is also made available to research students and members of staff.

Almost immediately after publicising the centre, there was an overwhelming response by the students which has continued to this day.

The centre is currently housed at the Faculty of Technology and is open to all students. It runs for four hours every Wednesday, serves an average of 10 students per week, and is serviced by three members of staff.

The centre was initially on a three month trial basis where students were asked to book the centre in advance and, where possible, were given a one-to-one tuition (three students maximum for the same subject at the same time).

The operating system was thought to be generally successful. The main problem encountered was repeat bookings by a number of over enthusiastic students who limited access to the centre for others.

The introduction of credit vouchers each worth 30 minutes of tuition time has almost eliminated this problem (a maximum of 5 vouchers per student per term are issued).

The credit vouchers also provide a useful way of keeping a record of the number of students who visit the centre together with the progress of individual students.

Those with a good knowledge of mathematics are actively encouraged to participate in the running of the centre and gain a useful teaching skill which they can then include in their CV.

Currently, based on students' queries at the centre, a handbook is being prepared which lists the most common questions and mistakes in elementary algebra and calculus with complete answers and guidance.

Future plans for the centre include expanding the opening hours to cope with the increasing number of students entering university at the foundation level and also introducing them to computer based learning.

Donna Mojab,
Mathematics Advice Centre,
Middlesex University.

Using the QuestionMark programme at Paisley

Mathematics Support Programme at the University of Paisley

The Mathematics Support Unit provides:

- Tuition during August for applicants with weak backgrounds relative to their chosen course requirements
- Tuition during August for students preparing for Aug/Sept. resit exams
- Short top-up courses for individuals and groups with known weaknesses in maths
- Strengthening the maths skills of students admitted to 'advanced levels of courses'
- A fully staffed, one-hour per day, drop-in service for all students
- Individual tuition for students with special needs

Uses made of QuestionMark authorware package by the Maths Support Unit:

- Supporting first year students:
  sets of tutorial examples, supported by some tutoring, accompany the course books for the mathematical sciences course
- Teaching Calculus:
  sets of examples in standard topics of calculus are available for the use of all students
- Diagnostic assessment of an individual student's maths abilities:
  sets of examples covering topics in high-school level maths are used
- Exam preparation:
  solutions to exam papers from recent years, with hints, are available
- Competency based assessment:
  used in a course where short tests required success in all performance criteria. In addition, this course allowed reassessment as required. This course had formerly been a nightmare to assess.

Dr Elizabeth West,
Director of Mathematics Support,
University of Paisley.

These articles are part of a series of case studies on maths workshops - readers are invited to send us the story of their workshop

The Nature of the Tutor's Work at Luton

For an ordinary lecture, tutorial or seminar, a lesson is prepared and is to a large degree controlled and limited by the tutor; in addition, the tutor is arguably in the position of expert in the particular area of study.

For a drop-in maths workshop, the content is client-driven; it can, and does, present the tutor - at a moment's notice - with any topic in mathematics or statistics, either on its own or applied in a quite specific and technical way to any type of engineering, computer science, operational research, analytical science, life science, social science, and the world of business and finance.

The student may be capable of dealing with a knotty problem in advanced mathematics; if the maths concerned is trivial, the problem is that a weak student becomes panic stricken and must immediately have a foot placed on the ladder of self-esteem. Sometimes a class teacher has expected too much, and the result is a bewildered and angry student, so that not only must the maths be taught but a bridge built to enable the student to make progress in that class. Moreover, there are rarely only one or two students requiring rapid succour – very often there are five or six at once.

The tutor must be:

- able to deal with any aspect of mathematics or statistics
- aware of their applications over a wide range of 'main' subjects
- an expert analyser and re-synthesiser of student minds
- an interpreter of students' class notes
- able to create the 'feel-good' factor out of an apparent disaster area

These are high level skills – and not rapidly attained by the mathematics specialist working in even a stable educational environment. The widening of access to higher education and the rapidly-developing subject base, means that both student experience and subject matter are far from what a tutor would have expected to deal with, say, ten years ago.

It is a curious thing that, when a new course is validated and I ask the course manager what type of maths, statistics, or indeed any numerical work the students are expected to be able to handle, the reply is often, "Oh, very trivial!" or "We do it all on the computer". However, the result is a scurry of students into the maths workshop wanting to know about percentages, or how to use the statistics mode on the calculator, or seeking reassurance that the computer printout has some meaning behind it.

Where it seems to be the case that a course has mathematical expectations beyond the students' experience or ability, they can be urged to make a formal request through the Quality Monitoring procedure, for this fact to be recognised by the course team and some relevant maths tuition provided as part of the course.

Ideally, the Quality Monitoring procedure should insist on a "maths audit" at the module-design stage of a course. The maths workshop staff could assist here by running "maths awareness" seminars for specialists in other subjects. Such specialists are often not aware of the conceptual and technical demands they are making on students who may have a very shaky grasp of this subject which they

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Tutoring in the Maths Workshop

We have this assignment and our group can't agree. Three of us think the line of best fit cuts the y-axis at 422 and I thought I followed the textbook perfectly but got a result of -405 for the y intercept, which we call '**c**'. I calculated the slope as about 0.28 and the others agree with that.

I used a different method to find **c**. Instead of examining the y axis, I calculated it using the formula for a straight line, Y = mX + **c**, where m is the slope and c the y-intercept. Using one of the points of the line, (FTSE = 3034, Co. share price = 429), and the slope m = 0.28, c has to be the number that makes the equation true.

When you plug in the numbers you get 429 = 0.28(3034) + c , and this simplifies to 429 = 850 + **c** , and the only number you can add to 850 to get 429 is -421. *(table 1)*

Tutor: So what did you do when you found out the rest of your group got a different value for **c**?

Student: I checked the slope value with two different points on the line.

Tutor: What did you find?

Student: The same result.

Tutor: Did you explain your work to the rest of your group?

Student: Yes, but they insist that **c** is where the line cuts the y-axis. They are right, aren't they, and I can't understand why my **c** is so different.

Tutor: What did you think was wrong when you first understood what your group was saying?

Student: I thought my signs were wrong.

Tutor: Do you still think that?

Student: I don't know. I know my method makes sense but the answer doesn't make any sense. I can see that the line of best fit crosses the y-axis at 420 something.

Tutor: Where is the y-axis?

Student:(points to the vertical line in table 1).

We pause to think.

Tutor: Suppose you drew an x-y graph from scratch. Where would the y-axis go?

Student: Through the zero point on the x-axis. . . I can see that my graph doesn't start at zero. Does that matter?

Tutor: Where is the y-axis on this graph?

Student:(again points to the vertical line in table 1).

We pause to think again.

Tutor: Why don't you draw me an x-y graph of senior lecturers' incomes and the values of their houses? Don't worry about the points, just draw, scale and label the axes. I'll add in some typical points. *(table 2)*

Tutor: Where is the y-axis on this graph? (in table 2)

Student: Oh. . . oh. . . . we could draw the lines closer , couldn't we, to get a better look at the data. (Student goes back to the table 1 and extends the lines of best fit way to the left to where the real y-axis might be.) Oh yes, it could be. Thank you very much.

Tutor: What are you going to do now?

Student: Tell the other students they are wrong!

Tutor: Are they wrong?

Student: Oh yes, I can show them both graphs together and they can then see both y intercepts and choose the one on the 'real' y-axis.

Tutor: Can you show me on the graph we've just drawn?

The student draws table 3.

****

Table 1

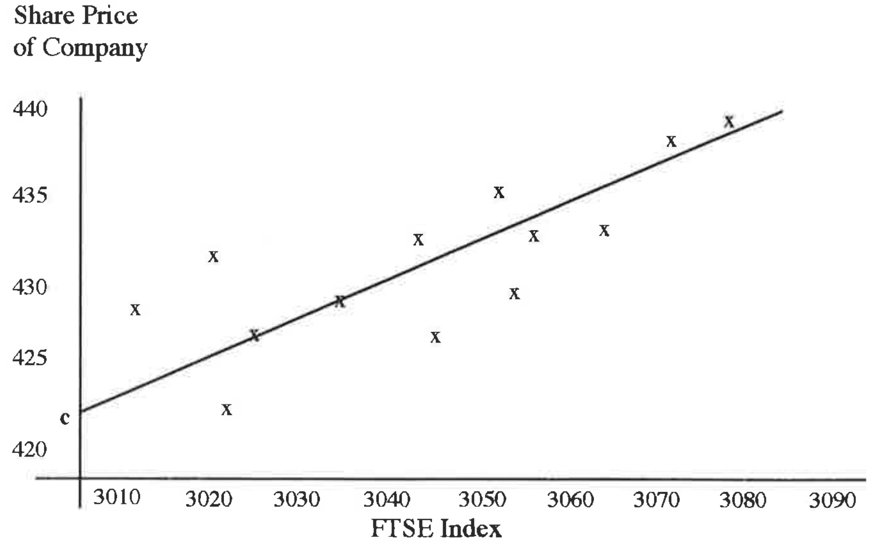


Table 2

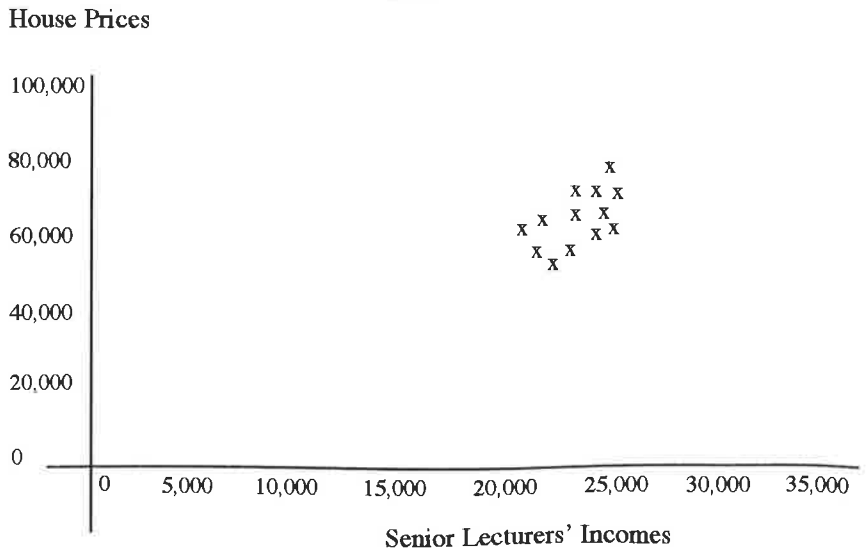
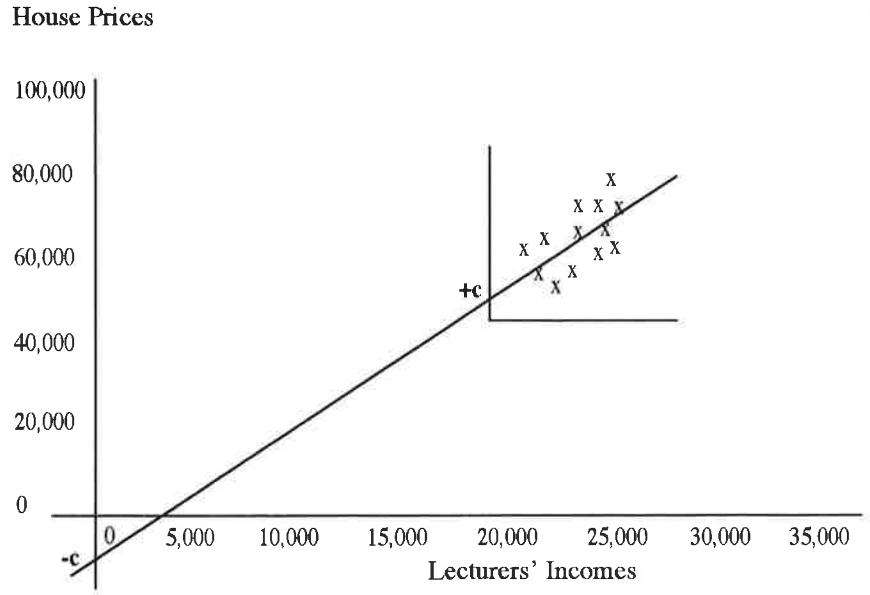


Table 3



This particular problem is fairly common in the S.U.M.S. (maths) workshop. We notice its occurrence in level 0 and level 1 from students of all faculties. It crops up again when level 3 projects are done and non-specialist maths students have to apply statistics 'learned' one, two or more years ago.

> I would invite maths tutors to submit their own stories for a series of 'conflict situations' in which students work through misconceptions.

We need to document the range of students' naive beliefs about each numeracy concept that impedes the quality of degree work. For every commonly held naive belief, such as in this article, more of what Professor Berry at the University of Plymouth calls 'parallel situations' can be created.

Introducing into lectures more problem-solving situations using collaborative groups can produce an environment where firmly held beliefs about maths are challenged.

The lecturer would only intervene when an entire group gets stuck or ensnared by their naive beliefs. To broaden the appeal of this approach, sets of ready make 'parallel situations' may usefully be published for each maths module.

A problem-solving approach leaves the challenge for students which is at once more enjoyable and motivating than to be told. The improvement in mathematical thinking by facilitating a real dilemma is greater than when rules are provided for its resolution. Of course, we need rules too, but in this article the student knew the rules. Learning was achieved by the individual process of making sense of them.

Research is wanted to make such a learner centred approach possible. Tutoring in the maths workshop with maths educators is a forum for such research. The process of learning is not a direct route and mainstream lecturers benefit from developing their tutoring skills.

Once again, the maths workshop provides a place for that to happen. Teaching numeracy to adults requires that their beliefs be respected as well as challenged. Very often beliefs about maths are firmly fixed and based on what is intuitively reasonable. The labelled vertical line in table 1 looks like the y-axis but it isn't. Dislodging such beliefs is not easy.

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Diagnostic Assessment

1 Introduction

The use of computers in mathematical assessment is beginning to become a practical possibility. The field of computer-based assessment in mathematics has been growing quickly in the last few years

The original work was probably carried out as part of the CALM (Computer Aided Learning in Mathematics) Alvey projects based at Heriot-Watt University in the 1980s [2].

The first UK 'mini conference' on the subject was held at Brunel University in September 1994 (previously, there had been a one-day workshop at Heriot-Watt University in December 1992) [4].

At this event, the five keynote speakers all came from institutions where computer-based assessment of mathematics had been used successfully with several hundred students. In a report of the mini conference [3], a table is given of 18 systems developed or currently under development in the UK at 13 different universities or consortia of universities.

Computer-based assessment will be one of the main themes at the International Conference in Technology in Mathematics Teaching at Napier University this September, 1995.

The field is not limited to the UK, although the widening of UK Higher Education intake has led to a targeting of resources, including computers, to support basic mathematical skills in science courses. I have recently come across an article describing the computerisation of some of the standard university science entry examinations in the States [5].

As in the wider use of computers in mathematics education, although the development work is mainly taking place in HE sector, many of the systems produced are also likely to be of interest and used in the FE and schools sectors.

In the rest of this article is an overview of the systems currently available and a description in more detail of the project on which I am currently working - a diagnostic assessment system called *Diagnosys*. I hope this article will help readers to begin to *appropriate* these software systems according to their individual requirements.

2 An Overview of the Types of System Currently Available

At first glance, the whole field of mathematical computer-based assessment systems can appear quite confusing, with a variety of sizes, input types, ways of recording marks, platforms, uses of graphics, degrees of customisability, etc. I shall attempt to summarise the main distinguishing factors in the currently available systems.

Most systems work on PCs and a majority also require Windows. Most systems can be used either over a network or on stand-alone machines and most record student achievement in some form.

2.1 Uses of Assessment

In her article [3], Pam Bishop classifies the uses of computers in assessment into four categories. Any one system may be used in several different ways.

Diagnostic - assessment used to diagnose student ability at the beginning of a course. See below for a description of the diagnostic assessment system called *Diagnosys*.

Self-test - assessment used by a student on his/her own, normally in a formative way. This is the quickest and easiest form of assessment and can be likened to students going through example sheets.

Monitoring - assessments used to evaluate students' progress through a course. The results are useful to both the student and the tutor and may be recorded over a computer network. The assessment used by the CALM system [2] is an example of this.

Grading - assessment used to evaluate student performance at the end of a course. Moves are being made in this direction, but there are problems in terms of security, authenticity, and correct evaluation of student answers.

2.2 Customisability/ Authoring Language

At the two ends of the customisability spectrum are **stand-alone systems** and **authoring languages**. Stand-alone systems are very difficult to change but require minimal effort to use. Authoring languages offer much flexibility but require a high investment in effort and technical ability. In between these two extremes lie what are known as **shells** which can be customised with a medium amount of effort. *Diagnosys* is best described as a shell.

The situation is somewhat confused by the fact that some of the stand-alone systems have been written using authoring languages. Two of the most popular authoring languages are *QuestionMark* and *Testmaker*.

QuestionMark is a general assessment authoring environment offering simple graphical question construction facilities. It does not cater for mathematical assessment. *TestMaker* is a mathematical assessment authoring language requiring more effort to construct questions which are less graphically appealing, but may be more appropriate to mathematics.

2.3 Types of Answer Input / Evaluation

There is a variety of possible answer formats. Again, a given assessment system may support several different formats.

Multiple choice - this is the easiest form in terms of authoring, input, evaluation and recording. However, as for paper-based tests, the main criticism is that it encourages users to distinguish between potential answers on the screen rather than turning aside and thinking about the problem. *Diagnosys* includes a 'list of choices' input which partially gets over this problem.

Numeric - this is the next easiest input format and most systems support it.

Algebraic - this is the most complex format and causes a lot of problems, in evaluation especially, (e.g. asking for an algebraic expression in simplified form means that terms should be combined but they can be written in any order). There are also problems in answer input, especially where brackets are required to emphasise operator priority (e.g. fractions involving expressions).

Graphic - some systems allow you to do things like draw a line on a graph or drag a function curve onto a graph.

Structured response/adaptive - some systems have a fixed sequence of questions, others allow the user to choose which question to ask next, or to go back over previous answers.

3 North East TLTP Project

The Teaching and Learning Technology Programme (TLTP) is an HE funded programme with the aim of developing computer-based support materials for a variety of disciplines. There are three mathematics projects, one of which is based at the five North East universities. The main product from this project is a computer-based diagnostic test of basic mathematical skills called *Diagnosys* [1]. It is a PC program running on the lower grade machines, neither requiring Windows nor a mouse.

The test covers a variety of areas (arithmetic, algebra, trigonometry, statistics, etc.) at a variety of levels (roughly pre-GCSE to A-Level). It is designed to be taken at the beginning of a course to give fast and effective feedback to students and tutors.

The test takes about an hour to complete and uses qualification information and the knowledge-based technique in an attempt to ask only relevant questions and make inferences on other skills (e.g. If a student gets a question wrong, the system infers that (s)he cannot do harder questions dependent on the given question).

Utilities have been written to collect student records and display them as Excel files. The test uses a variety of input formats including multiple choice, lists of choices, numeric and algebraic.

Diagnosys has been used with over 1000 students at the five North East universities on a variety of different foundation year and first year science courses. It is fairly straightforward to customise the test in a simple way (e.g. changing the names of courses supported and the respective subsets of questions which are tested).

A deliverable version will be released to all UK HE institutions under the TLTP agreement around Easter this year and steps are being made to market it to the FE and the schools sectors. So far, about 28 demonstration copies have been sent out and the project has received a further 30 enquiries.

The project has also been producing both text and computer-based support materials relating to the test and common errors.

Peter Samuels will be demonstrating Diagnosys at the Mathematics Support conference on 14 September in Luton

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Computer Algebra Threat/Opportunity?

Introduction

Computer algebra systems (also known as symbolic manipulators) such as Mathematica, Maple, and Macsyma, have been available for some time. However, due to their high cost and sophisticated features, it has until recently only been university departments and research centres which have used them in their work or in specialist teaching.

In the last two or three years, as costs have fallen, computer algebra systems have become a more viable prospect for everyday use in universities, colleges and even schools. The software DERIVE [1] broke new ground in this respect by providing a range of powerful features in an easy-to-use program distributed on a single floppy disc! At the time of writing, it is envisaged that a hand-held (or pocket) computer running DERIVE will come on the market by the beginning of 1996 at below £200. It seems inevitable that in a couple of years, the price will have dropped to that of a good graphic calculator today.

'an opportunity to explore'

What can DERIVE do?

It is perhaps simplistic, but not unreasonable, to claim that DERIVE can carry out, at the press of a button or two, most of the things that most students of mathematics do most of the time. Its features fall into four categories:

1. Arithmetic: to any specified decimal accuracy; fractions; complex numbers; surds; exact form; etc.;
2. Algebra: factorisation; entiation; integration; etc.;
3. Graph plotter: explicit, implicit, polar, and parametric plots; zoom and trace; curve fitting; 3D plots; etc.;
4. Simple programming: creation of utility files.

It is the algebra facility that is set to have the biggest impact. How much time do we currently spend inculcating routine algorithmic techniques for solving quadratic equations, differentiating products and quotients, solving differential equations? Is there any real point in all these fancy tricks if the "answer" can be obtained simply by typing the equation into a pocket computer and pressing the "solve" button? Does this not undermine much of our work as teachers? Do we have a confident response?

Threat or Opportunity?

Already, arguments are being put forward on both sides of the debate. For its supporters, computer algebra provides an opportunity to explore mathematical concepts in a dynamic new environment, free from the drudgery of carrying out tedious and error-prone algorithms by hand. Such algorithms frequently become an end in themselves, and detract from the main goal of mathematics, of formulating and solving real problems.

For its opponents, computer algebra is yet another step down the slippery path of falling standards, which encourages over-reliance on technology to the detriment of students' own skills and ability.

It is essentially a re-run of the debate which accompanied the introduction of calculators in school arithmetic classes. In colleges and universities, where algebra and calculus form a major part of mathematics courses, fears that the traditional methods taught to cope with standard problems could be made redundant by a hand-held machine may well cause an identity crisis on the part of some lecturers. But on the other hand, it is precisely the topics of algebra and calculus which cause difficulties for many students, especially those on foundation courses or for whom maths is not a main focus. How can the undoubted power of computer algebra systems such as DERIVE be harnessed to support students and encourage meaningful progress in their studies?

'yet another step down the slippery path of falling standards'

The "scaffolding metaphor"

One of the most convincing arguments has been provided by Kutzler [2]. He argues that the traditional "house of mathematics" consists of storeys (arithmetic, basic algebra, equation solving,. . .).

'provides a scaffold'

For the construction of the next higher storey to begin, the lower storeys must be firm and sound. Success in the endeavour breaks down if the previous storey is shaky or incomplete, and students' progress (and confidence) collapses altogether if they are expected to move up to work on the next storey when those below are inadequate.

Computer algebra systems, claims Kutzler, provide a "scaffold" which can support the next storey and allow work on it to be carried out, even though the foundations below are weak. In practice, this means a conscious decision to acknowledge certain deficiencies in lower level work, and delegate this to the computer, in order to be able to progress to the next level. For example, a student who has not (yet) mastered the solution of quadratic equations can nevertheless proceed to analyse the stationary points of a cubic by relying on the "scaffold" to support him/her over the "hole" of solving $dy/dx = 0$.

The way ahead

We need more than ever to be clear about the aims of our mathematics teaching in the light of the increasing availability and affordability of computer algebra systems. We should not automatically assume that allowing their use is "cheating".

For students who specialise in mathematics (at A-level, on maths degrees) a variety of publications exist (e.g. Berry et al [3]), which show how computer algebra can enhance the learning of the subject. For the increasing number of students who come to mathematics with less confidence or less motivation, computer algebra can provide a support to allow them to succeed in some areas of work - particularly application - despite having a shaky base. Kutzler's "scaffolding" didactics point the way towards a re-appraisal of how we structure our mathematics delivery, in particular with reference to levels of expectation and pre-requisites.

References:

[1] DERIVE - A Mathematical Assistant for your Personal Computer. Soft warehouse, Honolulu, USA. Distributed by Chartwell-Bratt Ltd., Tel: 0181 467 1956

[2] Kutzler B (1994), DERIVE - The Future of Teaching Mathematics, The International DERIVE Journal 1, pp 37-48.

[3] Berry J., Graham E., Watkins A (1993), Learning Mathematics through DERIVE, Ellis Horwood, Chichester, UK

Readers who are interested in joining a network to share experiences in using DERIVE are invited to contact the author

David Bowers,
Suffolk College.
Tel: 01473 255885 x 6339
Fax: 01473 230054

"USING DERIVE IN THE CLASSROOM"
Monday 3 July 1995
Suffolk College, Ipswich

For teachers who are already familiar with the basic facilities of DERIVE and who wish to deploy the software more effectively in their teaching. Ideas, advice, case-study reports and practical working sessions under the guidance of experienced tutors.
This more advanced course is now in its second year

Details from Dave Bowers (above)

Maths Phobia

Multiplication is where,
I always feel despair
even though I try in vain
number facts to retain.
Poor performance is repeated
as I'm often defeated.
I watch on in awe;
they're asking for more!
But I just feel rotten
because I've forgotten
my tables.

Embarrassment and fear.
The answer should be clear.
Is it because I'm unable
to remember my times table?

I know what's in store,
teacher opens the door.
The wrong answer I utter
down in the gutter;
the answer is unknown.
My classmates they groan,
I can hear the sound
when they all look around.
I really can't divide
my stupidity tied
to my tables?

Embarrassment and fear.
The answer should be clear.
Is it because I'm unable
to remember my times table?

Wendy Fortescue-Hubbard,
School of Mathematics & Statistics,
University of Plymouth

Diagnostic Teaching

An alternative approach to teaching mathematics to GCSE repeat candidates in Further Education

The Shell Centre is a self-financing centre for research and development in mathematics education. Its main focus until now has been the mathematical understanding and assessment at secondary level, although team members were involved in some work for NCVQ. During conversations with lecturers in FE and attendance at conferences it became apparent that most participants in Further Education feel there is a great need for research. Consequently we wrote proposals and submitted them to appropriate funding bodies, to investigate alternative forms of teaching mathematics to students in Further Education. Our initial intention was to look at the reactions of repeat GCSE students and their lecturers.

Evaluating GCSE retakes at FE Colleges

Further education colleges contain thousands of students aged 16-19, currently attempting to gain GCSE qualifications. In many cases, students are repeating their courses for the second time, in one year, in order to remedy earlier failures or to improve poor grades. Evidence from Audit Commission/HMI investigations (1993), however, give cause for concern: "Looking at the results of students taking three or more GCSE subjects, the general level of their GCSE gain is unimpressive." There is no evidence to suggest that the teaching methods adopted in such courses are any different from the methods that have been used and, for these students at least, have failed at secondary level. The proposed research seeks to discover if repeat one-year GCSE mathematics courses can be made more effective through the use of diagnostic teaching.

What is Diagnostic Teaching and how does it differ from Diagnostic Assessment?

Diagnostic teaching, in which students are faced with a "cognitive conflict" through a systematic confrontation with their own errors and misunderstandings, has shown considerable promise as a method of achieving long term learning in secondary educational contexts.

> 'studies show the superiority of a "conflict" over a "positive only" approach'

Much of the previous work on diagnostic teaching, however, has focused on the intensive teaching of isolated areas of content over a few weeks, with evaluation of learning outcomes after at most a few months (Bell et al 1985). These studies nevertheless provided encouraging results when compared with conventional teaching approaches.

The general theory underpinning diagnostic teaching can be viewed as both constructivist and developmental in origin, where cognitive development is the result of a series of events provoking the dynamic equilibration model between assimilation and accommodation. The learning effects do, however, appear to constitute a robust phenomenon open to a variety of interpretations.

The first of a series of studies on comparative experiments (Swan 1983) showed the superiority of a "conflict" as against "positive only" approach to the teaching of decimal place value. The positive only approach focused on the areas that were known to cause difficulty and the correct concepts and procedures were evolved without explicit discussions of misconceptions, while the conflict method first led the students into exposing alternative student conceptions before holding a discussion leading to resolution.

Key Features

These studies and some by others give considerable cause for optimism for an approach to teaching which:

- clearly identifies students' prior states of conceptual understanding through pre-testing
- targets the specific conceptual obstacles and misunderstandings thus exposed
- employs sharply focused discussion material, intended to provoke "cognitive conflict"
- engages students in cognitive and metacognitive activity aimed at describing and explaining strategies and errors
- shows some evidence of longer term as well as immediate gains

The Research Plan

This research, which has now been funded, will allow us to begin to analyse the consequences of following a more extended diagnostic programme with a greater number of mature students, who have underachieved at GCSE mathematics. It will take place over the next two years.

Kath Hart and Malcolm Swan,
Shell Centre for Maths Education,
University of Nottingham

Malcolm Swan is leading a working group discussion on this topic at the forthcoming conference (see pages 22-23).

CONFERENCES

ALM-2

Adults Learning Mathematics: A Research Forum
7-9 July, 1995
University of Exeter
Contact: Anne Chammings
Tel: 01392 411906
Fax: 01392 436082
Cost: £130 for everything.
Themes: research into adults, mathematics, and related teaching and learning issues.

BCME-3

British Congress of Mathematics Education
13-16 July 1995
Manchester Metropolitan University
Contact: Frank Eade
Tel: 0161 247 2000
Cost: £195
Themes: IT and maths; curriculum, social, and political issues; innovative practice.

PME-19

Psychology of Mathematics Education
22-27 July, 1995
Universidade Federal de Pernambuco, Recife, Brazil
Contact: Prof. Luciano de Lemos Meira
Cost: $320
Tel: 55-81-2718272
Fax: 55-81-2711843
E-mail: LMEIRA@cognit.ufpe.br

PDME-3

Political Dimensions of Mathematics Education Conference
24-28 July, 1995
University of Bergen (Norway)
Contact: Kari Vik
E-mail: KariVik@psych.vib.no
Cost: $100 fee + $3-500 lodgings
Themes: an international look at the political dimensions of mathematics; spans the whole spectrum of maths education; theoretical models of the role of maths in society; implications for teaching and learning.

ICTMT

Internat. Conference in Technology in Mathematics Teaching
4-7 September 1995
Napier University, Edinburgh
Contact: Tom Scott
Fax: 0131 455 4232
Themes: technologies that enhance learning.

MSFHE-2

Maths Support in FE and HE
14 September 1995
See pages 22-23 of this issue

ICME-8

International Congress on Maths Education
14-21 July 1996
Seville, Spain.
Contact: fax: +34 5 4218334
Themes: everything; biggest coming together of general mathematicians and maths teachers this side of the Atlantic.

NETWORKING

CTI network

Computers & Technology Initiative
Contact: Pam Bishop 0121 414 4800 x 7095
This is the largest network of mathematics educators with around 2,000 users and a comprehensive newsletter
One line joining command:
Mailbase@mailbase.ac.uk
then respond with...
join_cti-maths<your name>

FE maths workshops network

Contact: Dave Bowers
Suffolk College, Rope Walk,
Ipswich IP4 1LT
Tel: 01473 255885 x 6339

Mailbase

How Mathematicians Work
This is a discussion group for all subjects relating to the behaviour and processes of working mathematicians.
Free newsletter.
Contact: Dr Allan Muir
Dept. of mathematics,
City University
E-mail: A.Muir@city.ac.uk

STEPS Statistical Education Through Problem Solving

Mission is to develop problem based teaching and learning material for statistics.
Contact: Colin Jex
Management Science Dept.
Lancaster University
Tel: 01524 593847
E-mail: c.jex@lancs.ac.uk

Adults Learning Maths: Research Forum

(see pages 18-19 in this issue)
Contact: Dr D Coben
Goldsmiths College, University of London.
Fax: 0171 919 7313
E-mail: aea01dcc@gold

Center for Educational Change in Mathematics & Science

Contact: Professor Julian Weissglass
University of California at Santa Barbara
Tel: 00 1 805 893 7046
Fax: 00 1 805 893 3026
E-mail: weissgla@edu.ucsb.math or cbs%uk.ac.nsfnet-relay::edu.ucsb.math::Weissgla
The focus is on small group instruction in mathematics and has a holistic view of learners of mathematics.
The last 20 years of research and thinking in this area have been most clearly stated (author's view) in this latest paper:
Weissglass J (1994) Changing Mathematics Teaching Means Changing Ourselves: Implications for Professional Development. Published in NCTM yearbook, 1994, edited by D Aichele & B Reston pages 67-78. (National Council for Teachers of Mathematics).

Developmental Guidelines for Higher Education

Changes in students' mathematical backgrounds

Lecturers often complain about the standard of the students' mathematics. Are these complaints reasonable or do we sometimes use them as shield to hide inappropriate teaching strategies?

Nowadays we cannot expect our students to be fresh from school with a nice, relevant, recent clutch of O- and A-levels. Neither do many have the conventional study skills of essay writing and exam performance or the fluency in algebraic manipulation that comes from years of compulsory schooling.

Students of mathematics, on whatever course, now present us with a wide and challenging mixture of needs.

Our students are now older, more likely to be black or female and more likely to have worked inside and outside the home before or even during their study. They often bring with them a wider, more sophisticated and motivated interest in their studies. Students may also have some well-practised abilities in practical or oral mathematics, perhaps learned in the workplace.

Strengths of today's students

Whatever their age, if they have recently taken GCSE or A-level maths, or been on an Access course, students may have had experience of group projects, and have investigated mathematical ideas well beyond conventional syllabuses.

They will have been encouraged to reflect and write about maths. They will probably have studied subjects such as statistics, perhaps enhanced by computers, which were unknown in the school syllabuses of the 1960s - which many lecturers seem to remember with such fondness.

In those days graphs were taught as an aspect of coordinate geometry - now graphical methods are used throughout maths and other subjects. Many have forgotten their school maths or never really learned it in the first place. Many have half-remembered bits of it, sometimes wrongly. Mature students have often taken and passed, failed, or given up on a range of different courses in Adult or Further Education, each involving some maths.

Student attitudes

Not only that, but their attitudes towards maths are conditioned by those experiences. Older students have frequently experienced repeated failure at an elementary level in maths; it is well documented that fear and anxiety affects learning. How many of us have colleagues in arts and even social science disciplines who claim (sometimes proudly) to be innumerate, who even repeatedly failed O-level maths and yet have succeeded as professionals.

A dangerous misunderstanding

The changes in the school curriculum and developments in Further Education have been badly publicised and ill-understood in Higher Education. It is distressingly common for students on degree courses requiring a GCSE pass in maths at entry to be required to take 'revision' or, even more derogatively, 'remedial' classes in topics which are in fact quite new to them, such as logs, algebraic fractions and sometimes even calculus.

A reactive culture among HE lecturers

Lecturers' frustrations at their students' inability to grasp these (to us) elementary ideas soon affect attitudes towards study. The understanding which students do have is undermined by these labels and attitudes.

Much of this is not new. What has certainly changed is the demand for us to teach some mathematics to students majoring in an increasingly wide range of subjects.

The changes in the student body and the curriculum offered are irreversible. To complain about falling standards is rather meaningless and smacks of elitism.

It is also frustrating and likely to be ineffective to continue to pretend that all students have a homogenous knowledge base so that the teaching can continue on the old didactic lecture and drill method.

Organising feedback

Conventional teaching, because it places the teacher at the centre of the process, makes detailed feedback from students hard to obtain and encourages the retreat into frustrated complaining by staff and surface learning by students.

When we allow students the space to talk about their maths learning, they overwhelmingly ask for more feedback, more individual attention and more chances to ask their own questions. All this takes time, and if we are to make progress in improving the quality of students' mathematics learning, we must look at a radical redeployment of the contact time we have with students.

I propose for discussion the following developmental guidelines for mathematics learning in preparation for Higher Education:

Build on student strengths

Students arrive with a huge range of experiences of, attitudes to and knowledge of mathematics. Particularly for the non-specialist, much of this is, of necessity, precarious, and needs careful consolidation. Existing achievements and knowledge must be safeguarded - too many students are demoralised by being told their existing qualifications and understanding are worthless.

Diagnostic teaching

Diagnostic testing is useful if it forms the basis for a learning plan for each student. Giving them all a test in week 1 and following it up in week 2 by a blackboard session on fractions or differentiation will not clarify matters for the confused, and is likely to bore or confound those who are already competent.

Quality learning materials

The diagnostic process must result in students being given access to a wide range of quality learning materials. These can include work-sheets, books and computer packages. They will be most effective if they are clearly signposted with learning outcomes so that students can understand what they are supposed to be able to do. Some maths courses are still taught with no more resources than a handwritten list of problems without even numerical answers.

Involve students

Students must be able to exercise some control over their learning. Increasingly, part time and full time students want to be able to choose the time, intensity and location of their learning. We must start to recognise that students learn at different paces, at different levels and in different styles.

As lecturers we hope to foster intellectual independence; to allow students to decide on their own study needs, and to decide how far they want to go, is a powerful way of doing this.

Lecturers facilitating learning

This open and flexible pattern of learning needs to be closely supported by quality teacher intervention. Students commonly tell us that they have no opportunity to ask, or do not feel comfortable in asking, the questions they want to ask of lecturers. They feel that a considerable amount of teacher time is wasted in blackboard expositions of solutions to problems.

It is common to be told ' Oh, we've done that one on the board'. Often this means that the students have watched the teacher do the example, and copied down the result in the vain hope it will sink in. This model of teaching leaves little to do for the student who does not understand.

Our job is to intervene to guide the students through the materials, to answer and ask questions, to test and extend the student's understanding. Students frequently use each other as a resource, puzzling through problems together. We should encourage and formalise this by providing time for it. Even in the current climate of rapidly increasing numbers it is quite possible to deploy teacher time successfully in this way.

Assessment

Patterns of assessment in maths are already changing, but there is a reluctance to embrace course-work, problem solving and group activities, despite the common complaint that students cannot apply mathematical concepts in practice.

Anyone who has observed a group of students getting to grips with a realistic problem can not doubt the richness and complexity of the mathematical learning taking place.

Setting and marking such assignments is hard, but surely much more interesting than ticking pages of sums (or programming a computer to do it).

Sybil Cock,
Centre for Educational Studies,
University of North London.

Schooling as Preparation for Life and Work in Switzerland and Britain

A Swiss student in the bottom decile outperforms the median British student at mathematics, according to the 1991 IAEP study of 13 year olds. 67% of Swiss students correctly identified the average of 9, 7, 6, 0, 2, 8, and 10°C, compared to 37% of British students. The study is flawed in that it forbade the use of calculators, in line with Swiss practice, but not with British practice. However, Swiss pupils don't cover statistics in their maths while British students do. Swiss students spend proportionately more time on algebra and British students on project work.

The observations of classroom teaching practice found that "most pupils (in British schools) work individually - even though notionally they are supposed to be working in groups". However, while British teachers want pupil-centred education and small group environments, they appear to lack the skills to make this approach work.

Swiss classes offer a more stable environment. Three year assignments with each class are common for a teacher at the secondary level. Moreover, that teacher is likely to teach several subjects to the same group, not just maths. The traditional syllabus means parents are able to help their children. In addition, all children have textbooks which they also take home, making parental help even more likely.

I put this view to a class of student teachers who responded that British children are better off without their parents help. Do teachers need to hold classes for parents to facilitate their children's learning?

Bierhoff H. & Prais S.J.
N.I.E.S.R.
Discussion paper No. 75.
Review by editor.

Putting numeracy on the modular map

CHELTENHAM AND GLOUCESTER COLLEGE'S CROSS COLLEGE NUMERACY PROJECT

Background

This article follows on from the two previous articles in Issues 1 and 2 of this newsletter where we reported on our EHE funded Cross College Numeracy Project which started in May 1993 and is now in its final phase.

The focus of this article is the introduction of a new module on numeracy into our Undergraduate Modular Scheme (UMS); this was a spin-off from the work of the above project.

Research undertaken as part of this project highlighted concerns both in our institution and nationally about students' levels of numeracy both for their courses and employment afterwards. A number of fields of study within the UMS curriculum contain quantitative methods in the first year of study.

A survey identified the need for underpinning numeracy skills. There is also evidence that employers of graduates are making increasing use of numerical reasoning tests in their recruitment processes.

Numeracy is more to do with a particular approach to numbers than with specific mathematical skills. The ability to interpret data and work from first principles is required rather than remembering formulae or using specific techniques.

Previous mathematical experience has often led to students lacking confidence to tackle problems in this way.

We therefore wished to introduce a module which would address the needs identified above and would build confidence in the students to enable them to cope better with modules involving quantitative work within their disciplines areas.

Description and Content of module

The module is called "Confidence Counts" - we had quite a debate about what to call it so as not to put students off with too "mathematical" title! We also wished to highlight its confidence building aspect.

Before the students undertake the module they take the diagnostic numeracy test (see Issue 2 Newsletter).

If weaknesses are identified, students are advised either to take the new module or attend a numeracy drop-in workshop. This test is offered to all UMS students at the beginning of the academic year.

The module runs over one 15 week semester - with 2 hours per week class contact; students are also expected to spend around 4 hours per week working on the module outside class. It is offered in both semester 1 and 2 of the first year of the UMS, with multiple runs in each semester.

The module is aimed at students from a variety of disciplines across the college but is not available to maths specialists or to students with a post GCSE maths qualification.

The first few weeks of the module are aimed at confidence building. Students' past mathematical experience is explored and their current mathematical skills reviewed. During this period students are encouraged to initiate a Learning Diary and reflect on their progress.

Students also establish a Learning Contract, based on feedback from the diagnostic numeracy test. This forms the basis of study for the next few weeks, when students work on independent study materials to remedy deficits in the areas identified by the test - broadly covering arithmetic, algebra, data interpretation and graphical representation.

The use (and misuse!) of the calculator is also explored. Students build up a portfolio of work week by week and this is assessed and graded.

In the second half of the module students work in groups on problems in application areas related to their disciplines. Each group is required to work on two specific areas which are assessed by means of poster presentations.

At the end of the module students retake the diagnostic numeracy test and have to reach a satisfactory standard in the core skill areas.

Getting the Institution on board

A great deal of preparation and background work was done to launch the module. We had discussions early on with the head of the UMS, who supported the development. Field chairs were already aware of the need for their students to address numeracy problems but not all felt they had space in their programmes to do so.

However, the UMS scheme does have some flexibility in year one to allow students to study areas other than their specific disciplines. It was considered important that students actually gained credit for numeracy work, through formal assessment, as part of their studies.

Field Chairs were consulted in the planning stages of the module and their views and those of the tutors of quantitative modules actively sought.

Once the module was approved, Field Chairs were contacted to give them detailed information about the module, diagnostic numeracy test and numeracy workshop and they were also asked to indicate whether they would be recommending the module to their students. 16 out of the 40 fields wished to do so.

Before the beginning of the academic year, Academic Counsellors (who advise students on module choices) were contacted to give them information about the test and its links to the module.

We also attended the induction meetings of the 16 interested fields to highlight the importance of numeracy and give information about support systems we had developed. (We discovered later that our work also got a mention in the head of the scheme's address to all new students.)

Getting the students on board

Students here have two weeks at the start of each semester, during which time they may change their module choices. The test was scheduled for the first week, with feedback direct to students and to their Academic Counsellors on the day following the test. We had five sessions for the test with over 400 students attending overall, and results were collected by them from a central point.

As a result, we had 120 students taking the module in semester one and over 80 are currently studying it in semester two. The students belong to fields which include: Business Studies, Computing, Geography, Leisure Management, Psychology, and Sports and Exercise Science.

In conclusion

So far the module has been very well received by both students and staff at the College and we are planning next year to extend the number of runs of the module from 6 to 8; 5 in semester one and 3 in semester two (of level one). The extensive planning of the content, delivery, and marketing of the module appears to have paid off.

Marion Canham and Viv Ferguson
Department of Mathematics,
Faculty of Business,
Cheltenham & Gloucester College

UNIVERSITY OF TEESSIDE'S UNI-WIDE MODULES FOR NON-SPECIALISTS

Rationale

A lack of numeracy skills is damaging to a student as it affects confidence, self-esteem, as well as job prospects through the increasing use of psychometric testing by employers.

Transferable skills such as 'quantitative literacy' and 'problem-solving' are enhanced by a more thorough mathematical grounding. Students wanting to change course, or to progress in knowledge and level need these skills in particular.

Description

Introductory Mathematics for Non-Specialists and Introductory Statistics for Non-Specialists are validated for inclusion in several courses as level 1 options. The pre-requisites are not to have done any maths beyond GCSE. Students attend one weekly lecture and 3 hours of directed study over 15 weeks.

Features

- team teaching
- an adult approach
- use of maths workshop
- open learning material
- small collaborative groups
- competency based assessment.

Syllabus

The numeracy module covers number systems, using calculators, fractions, percentages, linear functions, bar graphs, scatter diagrams, and as much as possible in the context of meaningful applications.

Safety

An 'open book final' makes the module acceptable to maths anxious students - the focus of assessment is understanding as well as competence.

Evaluation

Fifty students enrolled in the first year. It was found that many enjoyed mathematics and statistics for the first time. Several course tutors have been won over to promoting the module.

Case Studies of two carefully implemented modules

Problems

1. Students note-taking skills were weak and so extensive worksheets had to be written so that students could concentrate on class activities.
2. Communication skills of the students were enhanced to the benefit of all their work.

Recommendations

As well as formal summative assessments, the need to develop optional formative assessments is now apparent.

Pat Egerton & Michael Cummings,
School of Computing & Mathematics,
University of Teesside.

Summary of an original article in SEDA paper 87, by the editor

Introducing Reflective Journals in Numeracy

Rationale

Lack of confidence in maths comes less from mastery over content than from past experiences learning it. The reflective journal provides a place for you to document confidence issues, content issues, teaching issues, and other learning issues.

Reflecting back to key moments when you have insights allows you to relive those good moments. Re-reading them shows you how often you kept going when you were stuck. It offers a broad perspective by charting your progress over a long period.

A letter to students informing them how to reflect and why it helps

There are higher level thinking skills that will develop by reflecting on your learning. These include thinking about your thinking (metacognitive skills) and a realisation of the affective side of learning and problem-solving.

Reflection

When you get home, think back to the class-work. After you have finished reading some maths text, think back to when you began it. Identify a significant situation that stands out; either in the classwork, or in homework, or in both. Concentrate on the situation(s) that stand(s) out, so you can recall different sensations: people, objects, smells, daydreams, emotions.

Reflecting requires two activities: to think back, and to construct an image. When you reenter the situation to reflect on it, try consciously to do both things. Consider, after a while, what alternatives you had. The point is to become familiar with the difficult or significant situation you are reflecting on so that you will quickly recognise them again when they reoccur. The alternatives you have worked out in your mind are much more likely to be attempted in the future.

Description

The following are a list of themes which may help you get started with your reflective journal:

- identify what is causing trouble
- reflect on both teaching and learning issues
- document feelings engendered during this learning process
- reflect back and identify points where you feel like giving up: consider what you usually do to cope with that which does not seem to be working
- reflect on your ability to ask for help and who came forward
- consider how to explain a problem; What difficulties arose? (for example in the relationship between you and the person offering help)
- what did you do to follow up the ideas you found interesting?
- have different explanations helped or hindered your understanding?
- are there errors you find yourself making regularly?
- look for patterns in the difficulties encountered
- look for strategies that have worked in similar situations

Evaluation

Homework content. A common practice is to write on issues arising from homework. In one style all homework is written in one book with summary reflections. Another style is to write continuous reflections, where the left hand side of each page is for maths statements and the right hand side is for reflected thought.

Personal issues. An alternative is to pick a few key issues of content and follow them through in some depth.

Summaries. Almost all students find it useful to summarise their work, whether about homework, selected maths topics, or personal issues. At the end of the module, re-read the whole of your journal and look for longer term changes.

Follow up work. Students who follow up class activities often find persons who they ask for help become allies.

Affect. For most students, dealing with affective issues is useful but for some, past bad feelings about maths are so strong that to raise them at all hinders learning. One suggestion is to write about only the enjoyable moments. Look out in your summaries for changes in attitude.

Social skills. Many issues in small group management arise. Just as personal attitudes shift, the social interactions between students and lecturer, and between students and other students, are illuminating. Both sets of relationships are worth tracking over time.

Feedback on teaching issues. Perhaps the most useful aspect for me is the quality of feedback about teaching issues. Your judgements cause me to make adjustments in presentation or sometimes to drop an activity altogether.

Cost. Each reflective journal takes typically one-half hour and sometimes up to two hours to write each week. The justification of the time spent is based on the benefits for both teaching and learning.

Ian Beveridge,
Department of Mathematics,
University of Luton.

Adults Learning Maths

What is ALM ?

Adults Learning Maths : A Research Forum is a new international research forum bringing together researchers and practitioners in adult mathematics/numeracy teaching and learning to share ideas, information and research findings in order to promote the learning of mathematics by adults.

ALM now has members in the USA, Australia and continental Europe as well as the UK. We welcome new members and are keen to network with *Mathematics Support* and other organisations which share our interest in research on adults learning mathematics.

Where can I find out more about ALM ?

Details of ALM are in the ALM Newsletter, on the Internet on <numeracy @ world.std.com>; copies of the ALM Newsletter, are also available from Diana Coben at the address below.

Copies of ALM-1 1994, Proceedings of the Inaugural Conference of Adults Learning Maths : a research Forum (1995) ISBN: 0901 542 784 are now available - one copy will be sent free to current ALM Individual members and everyone who attended the ALM - 1 conference.

Individual membership is £10 per year, ALM - costs £5 per copy including postage and packing (please make cheques out to Goldsmiths College). For full details of ALM - 1 conference of ALM, contact: Dr. Diana Coben, Department of Educational Studies, Goldsmith College, University of London, New Cross, London SE14 6 NW, fax : 0171 919 7313 Email : aea01dcc@gold.c.uk.

What next for ALM ?

ALM continues to expand and ALM - 2 , the second ALM conference, will be held July 7-9 1995 at the University of Exeter. The Keynote Address - *Images of Mathematics, values and Gender: A philosophical Perspective* will be given by Paul Ernest and the provisional programme includes Mathematics Support's Ian Beveridge as well as :

Teaching Adult Students Mathematical Investigations *Richard Angiama*

Mathematics : Certainty in the Uncertain World ? *Roseanne Benn*

Knitting Tensions : the Prescription Verses the Visual *Sandy Black*

Using Reflective Journals in Numeracy Classes *Ian Beveridge*

Maths Life History : A Case study *Diana Coben and Gillian Thumpston*

Falling Standards - Impact on student Learning *Sybil Cock*

Mathematics in Women's Work : Making it Visible *Mary Harris*

Talking About Algebra *Sylvia Johnson*

Trying to Understand Their Thinking *Janet Duffin and Adrian Simpson*

Learning Mathematics by Patients in a Special Hospital *Ann Elsy*

A Multiplication Game for Adults *Wendy Hubbard*

The 'Look+See' Poster Series for Adults Learning Maths *John O' Donaghue*

Tutors and Students Muddling Through Together - Why Do Two Minuses Make a Plus ? *Joan O' Hagen*

Algebra for Adults : The Voices of the Students *Kathy Safford*

Adults Learn Maths in Austria *Dr Jurgen Maab and Dr Wolfgang Schloglmann*

MACS - A model for University-wide mathematics Support *Adrian Simpson and Janet Duffin*

Writing in a Basic Maths Group *Alison Tomlin*

What's the Difference Between a Puzzle and a Maths Question ? *Robert Eastaway*

Technological Competence and Mathematics *Tine Wedege*

The Adult Numeracy Teacher Research Project in Massachusetts *Mary Jane Schmitt*

All are welcome, with reductions for ALM Individual members. For details and to book your place, please contact: Anne Chammings, CET Division, DCAE, University of Exeter, Cotley, Streatham Rise, Exeter, Devon EX4 4PP. Tel: 01392 411906 Fax: 01392 436082.

Diana Coben, ALM Chair,
Goldsmiths College, University of London

Innovations in Maths Teaching

Innovations in Mathematics Education in Higher Education - edited by Ken Houston: A review of SEDA Occasional Paper 87 (SEDA is the Staff and Educational Development Association)

Eighteen case studies of good practice in mathematics teaching have been collected from HE institutions around the country.

The book is well organised with rationale, description, evaluation, and references for each case study. There is cross referencing between teaching and learning strategies, problems tackled, and transferable skills. As a result, using this book selectively is made very easy. If you are interested in innovative practice of CAL , the index identifies cases 4,5,8,9. If you want to introduce collaborative project work, read cases 9,11, 13,14, 16,17, and 18.

The consequence of too much analysis is that exact cross referencing has been abandoned by some writers in an attempt to describe the essence of their work. For example, the skill of problem solving is identified once only, though most cases involved problem-solving in some degree.

Another skill with only one entry was that of 'management/leadership'. Again, that is included in the large number of peer-group activities. Only one case listed 'financial resources' as the problem tackled, though all have resource implications.

While the introduction would benefit from consolidation into fewer than the 44 characteristics provided, the checklists provide a useful shell for further publications. It will also help readers organise their own submissions for validation of innovative maths modules.

The order of the case studies reveals a simpler grouping into five areas: (1) reading and writing about mathematics; (2) computing applications; (3) problem-solving; (4) basic numeracy; (5) assessment. The paragraphs below follow this order.

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(I) Reading and Writing about Mathematics

Ken Houston at the University of Ulster explains how he uses comprehension tests. Although his aims are common to all levels of maths, his objectives are to encourage greater insight when reading research papers.

Jane Mardell at Sheffield Hallam University outlines another approach to written work where mathematical articles with alternative approaches are paired, as are students, to open up mathematical discussion. Her article outlines the problems of implementing such activities. Bryan Orman at Southampton describes how students look critically at other students' written work and so to agree on standards of 'quality'.

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(2) Computing Applications

Professor Berry's team at the Centre for Teaching Mathematics in Plymouth has developed the teaching of calculus with Derive and worksheets. For example, one task is to find the general result from well chosen polynomials. It gives students some ownership of maths as well as developing skills.

Martin Fitzpatrick at Stranmillis College of Education in Belfast makes creative use of Mathematica software for the B.Ed final year project. His focus is to search for stepping stones to bridge the gap between 'novice and expert' problem-solving.

****

(3) Problem-Solving

Bob Burn at Exeter has developed a problem-solving module of number theory. It was developed for education students with good maths background, who found it highly motivating. Although most students did not complete it all, exam results were improved. It was found necessary to provide brief summaries of the content of each batch of 50 questions.

Ken Glass has a problem-solving module on non-routine problems entitled, 'Mathematical Investigations'. Students study four problems, each in a different social environment. The first problem is a collaborative group activity, then students work in pairs and the final two problems are undertaken individually. In a mechanics module at Plymouth, the philosophy is to encourage student thinking even when a naive conclusion is reached.

For example, *"A car is driving round a roundabout at constant speed. Draw a diagram to show the forces acting on the car"*. Presented with a conker swung around on a piece of string, it is clear the holder is exerting a force which pulls the conker towards the centre. It is the interventionist role of the lecturer that makes this case study interesting; "What would happen if you let go of the string?".

****

(4) Basic Numeracy

One response to increasing concern about worsening numeracy skills has been university wide modules in maths and statistics for non-specialists. Research at Durham into numeracy standards by Michael Cornelius preceded the development of these modules, and laid foundations for their inclusion into several courses at the University of Teesside.

Pat Egerton and Michael Cummings have incorporated many innovative features into these modules (see page 17 for details). Their continued success in attracting students may be expected, not only because of a fundamental need, but also because affective issues are addressed.

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(5) Assessment

At the University of Ulster, student projects are used as a peer tutoring resource. Students are asked to learn a new piece of technology, reflect on its teaching and learning possibilities, and apply it to a module they are currently taking.

John Berry at Plymouth also uses posters for communication and assessment in mathematical modelling. Peer assessment uses a checklist with an ordinal scoring scale for 10 features they wish to promote. In addition to receiving the assessment criteria at the start of a project, students discuss examples of good and bad posters and consider what makes quality.

Simon Andrew at Sheffield Hallam applies learning contracts to student projects in the mathematical modelling of software engineering problems. Computer based testing using QuestionMark Professional is described at the University of Ulster. At Napier University short interviews are used in project assessment.

****

Summary

This occasional paper by SEDA offers important general lessons for putting good ideas into practice. Foremost among these is the need to share aims and objectives of novel activities with students. Many of the subsequent adjustments required have been to provide extra feedback and reassurance.

Preparing good feedback is time consuming which may discourage a wider adoption of innovative modules. The use of peer assessment would seem to offer a way out of this problem. Using computers would also seem to work better when students have input into how and when they are used.

> there is a need to share aims and objectives of novel activities with students

Finally, the benefits of lecturers with like interests from different institutions working together is exemplified by most of these case studies being collaborative efforts.

Paper reviewed by the editor.

• *Copies of this paper can be purchased from SEDA by sending £8 to:*
Jill Brookes, Gala House, 3 Raglan Road, Edgbaston, Birmingham B5 7RA Tel: 0121 440 5021 Fax: 0121 440 5022

SI Sessions in College Algebra & Calculus

This paper has been accepted as a chapter by Jossey Bass in New Directions in Teaching & Learning.

SI is a peer support model of student learning. It typically involves a successful level 2 student facilitating a small group of level 1 students. Small groups of 'novice' students work through their lecturer's notes and textbook problems. SI sessions enhance tutorials in refining questions rather than providing 'answers'. The paper also looks at the small group management skills required.

There are six transcripts of SI sessions which covered:

1. mathematical concepts (e.g. continuity and limits)
2. solving problems (e.g. applications to conics)
3. study skills (e.g. reading proofs; preparing for maths exams)

Feelings of inadequacy around mathematics can inhibit original thinking of which a student is capable elsewhere. Peer groups operating within the SI process makes it easy for students to talk about what they know. Attitudes to errors can be re-evaluated as opportunities to understand one's thinking. Out of this, enough self-understanding develops to move on from patterns of thinking that don't work with 'difficult' problems.

The challenge of the SI student facilitator is to judge when students are ready to learn study skills; or when the students, as a group, have a firm enough grasp of routine problems to be challenged. .

If all this sounds a little idealistic, the basic skill of the student facilitator is simply listening to her student group. What is done well is that SI student facilitators are naturally interested in the students' ideas about mathematics.

S Burmeister, Cazenova College
J M Carter & L R Hockenberger (Oakland Univ);
P A Kenney (Univ of Pittsburgh);
A McLaren (Penn State Univ);
D L Nice (Univ of Wisconsin).
Review by the editor.

The Second National Conference in Maths Support in Further & Higher Education.

Keynote Speakers

Dr Ros Sutherland is a co-author of the report reviewed on page 1 of this issue, The Changing Mathematical Background of Undergraduate Engineers: A Review of the Issues(1995), written for the Engineering Council. She lectures at the University of London Institute of Education. One of her research interests is the teaching of algebra.

Dr James Wisdom is the head of education and staff development at London Guildhall University. He is particularly active in S.E.D.A. and is interested in undergraduate experiences with mathematics and statistics.

Working Group Sessions

1. Enhancing the Curriculum

We will look at a variety of teaching and learning strategies. We will also look at adapting the new modular courses to the demands of students. Led by *Marion Canham* & *Vivien Ferguson* of Cheltenham & Gloucester College.

2. Maths Workshops in Higher Education

Mopping up the tears or changing student learning? How can a drop-in workshop be more than just a remedial facility? Can the student centred approach be extended into the mainstream? Led by *Sybil Cock* of the University of North London.

3. Repeating GCSE - Teaching More Effectively How can we help GCSE failures?

What alternatives are there? Does Diagnostic Teaching (in which students reflect their own understanding) have any implications in FE? Come prepared to share, discuss, and reflect. Led by *Malcolm Swan* of the University of Nottingham.

4. SI Peer Support

Supplemental Instruction (SI) is a peer facilitation scheme which helps students to process their reading, notes, ideas etc. Using the SI model we will explore the ways in which we think students learn mathematics. Led by *Jeremy Levesley* of the University of Leicester.

5 Diagnostic Assessment

Information will be given about currently available diagnostic tests of numeracy and mathematics. A hands-on session of implementing a computer-based test for your institution will be provided. Led by *Peter Samuels* of the University of Newcastle.

6. Maths Drop-in Workshops (FE)

What benefits do workshops bring? How can we justify them? Resource them? Improve them? This working group will share good practice and new ideas. Led by *David Bowers* of Suffolk College.

Poster Session

Delegates are encouraged to bring a poster which outlines a research interest or teaching innovation.

The poster will explain your work, its importance, the method of approach, and any conclusions reached, however tentative. Informal discussions can take place around your poster presentation. In this way, we hope to facilitate networking.

In addition, each working group will summarise its sessions with a poster. This will inform delegates who are unable to attend a particular working group session.

MATHS SUPPORT HANDBOOK

The main features of this handbook will be:

- to provide descriptions of the most common and useful support materials for the area of basic mathematics (we will have to decide on the subject area, but I suggest we cover basic numeracy, basic statistics, GCSE maths, and the common core A-level syllabus; perhaps each in different sections)
- to give information on availability, costs, and cost-effectiveness
- to give details of how many institutions use the material and to what extent or in what way

Are resources simply made available as extra-curricular options? Do students use them as an integral part of their course? Together with this, it would be good for us to have one or more in-depth descriptions of use and evaluation of effectiveness of each teaching resource.

****

I would envisage this information being collected together and organised into at least three different forms:

1. A paper-based handbook.
2. A World Wide Web / ftp site or an on-line database.
3. A database available on floppy disk in a shareware package such as DataEase.

****

I would like to ask for collaborators who would be willing to take responsibility for:

- reporting on exactly what resources are currently used in their institutions, how they are used and to what extent
- giving an in-depth, critical review of specific resources

I want to involve others as much as possible, as early as possible, in order to share ownership of the handbook and its contents on current practice in the UK. Beyond its obvious uses in encouraging and informing the initiatives of individuals and of maths departments, it will give a broader perspective for research and planning.

The project will benefit from outside funding and although we have some useful leads, your ideas for further financial support are requested.

****

There are four similar handbooks that have guided my thinking. The first two have been reviewed in the first issue of this newsletter:

1. Andy Fitzharris' internal report on CAL packages to prepare incoming level 1 engineering students at the University of Hertfordshire.
2. Tony Grove's report on open learning materials for the Open Learning Foundation.
3. The CTI Maths and Statistics handbook.
4. The Scottish Learning Technology Development Initiative handbook.

I think we can combine the good features of all of these and produce something accessible and useful to anyone involved in maths support in FE and HE

Peter Samuels
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E-Mail P.C.Samuels@NCL.AC.UK

Booking Form

Please reserve me ________place(s) for the SUPPORT FOR MATHEMATICS IN FHE Conference.

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To confirm your booking, please return form with cheque payable to the University of Luton at the following address:

Sarah Cutler (Conference Secretary),
University of Luton,
Faculty of Applied Sciences,
Department of Mathematics & Statistics,
Park Square, Luton LU1 3JU

Tel: 01582 34111 ext. 2403 Fax: 01582 489212

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