FREE SAMPLE LP DB HV RS AW JMcQ MK → TH (last)

MATHEMATICS SUPPORT *Newsletter*

NATIONAL NEWSLETTER FOR ACADEMIC MATHS SUPPORT ISSUES 4&5 SUMMER 1996

Editorial

This organisation is a grassroots body concerned with students learning mathematics. Our primary concern is not with assessment but with the bold task of making mathematics a meaningful activity and not just for those who are good at it.

'Support' for some in HE has a 'remedial' image. This image does not seem to affect the FE sector to the same extent. In the interesting and often difficult areas of life, such as the intimate relationships between people as well as those between people and mathematics, support might well be considered essential.

Leone Burton (U. of Birmingham) comments: "My experience of FE practices is that they vary enormously from learning-based in a serious way through to worst possible squash them into packed lecture theatres and tell 'em. On the other hand, in HE it is more of the latter and little of the former. Unfortunately, those in HE do not seem to think that there is anything worthwhile to learn from colleagues whose focus is learning rather than the mathematics content. I think that is unhelpful to dialogue but particularly to students' learning."

It appears that we not only have an ineffectual intellectual establishment but also one which is unable to appreciate the good in the flawed efforts of those who do attempt to cope.

Mathematics Learning and Assessment Meeting at the Royal Society, May 1996

Sharing Innovative Practices

This was an important conference which put many of the ideas of mathematics support for non-specialist students into the mainstream agenda. Its aim was to make mathematics accessible to students.

The day was organised in three parts; two panel discussion events and one set of parallel workshops.

The first panel was chaired by Chris Haines of City University and had three speakers who addressed the broad theme of "Managing Change".

The second panel was chaired by Leone Burton of Birmingham University and her three speakers asked, "Why Innovate in Mathematics?".

The workshops were experiential events on the themes of: (i) groupwork; (ii) rating student achievement; (iii) comprehending comprehension; (iv) assessing assessment; (v) reflecting on reflections.

On entering the Georgian Royal Society building, I received a free copy of the Mathematics Learning and Assessment Pack, published by Arnold for £50. This completely stole my attention from the discussion of the first panel.

The 'discussion' turned out to be one question after each short speech. The first speaker told us why we had all given up one day at a busy time and the first question asked whether we would ever get enough resources (no!)

I opened Pandora's box, the polythene wrapped resources pack. The pack contained five booklets and a video with well presented accounts of projects funded by HEFCE's *Effective Teaching and Assessment Programme* (ETAP). Skimming through the booklets, I was excited to observe

continued on page 2

see back page for contents of this issue

Sharing Innovative Practices

from page 1

all the resources that were included, particularly in assessment. This will save me lots of time, I decided, and it was time for the second plenary session..

Why Innovate in Mathematics?

I suppose my idea of a panel discussion is the format of BBC radio programmes such as "Any Questions" and "Any Answers". Continuing on with the format of a ten minute speech followed by one (unanswerable) question, we got neither questions nor answers. Luckily Leone Burton is a very amusing chairperson and had selected three contrasting speakers, which stimulated informal discussion later on.

Professor Norman Biggs of LSE gave us a 'macro' view: social and economic pressures to change; institutional changes in response to these pressures. "The resulting problems are numerous", and he went on to explain that 'numerous' actually means 'horrendous' and 'horrendous' means there is a vacuum of support for the needed changes.

Nevertheless, the human spirit must not be crushed by impossible odds, so he recommends we carry on anyway the process of transforming mathematics to make it widely available. Mathematicians must learn this from economists; when you haven't got an answer, move obliquely into philosophy.

Professor Peter Saunders is from King's College and told us about his experience writing a statistics module with computer support for Biology students. While lectures became easier to write, exercises got harder.

He used the ability of the computer to select a random sample from a large data set to provide each student with unique data. In lectures, when discussing significant difference between sample means, the randomness of students' data sometimes provided contradictory results. Students were helping each other in ways he had not foreseen. "Everything you do impinges on everything else. Moreover, it is hard to get it right first time." He concluded, "My goodness, it's a lot of work".

Professor Ros Sutherland, of the University of Bristol, offered a constructivist view of learning as her starting point. It was useful to be reminded that students construct their own explanations for mathematical concepts all the time, whether enabled or hindered by their teachers.

The variability of students entering FE and HE is a function of the changes in mathematics experienced in secondary schools. She warns not to blame schools nor teachers for our problems of students with declining skills in algebra manipulation.

She hints that changes in students' mathematics have more fundamental roots than government policy or lack of resources. Lecturers socialise knowledge at many levels and do transmit their values more effectively when they engage in a dialogue with students.

Groupwork

We were divided into three small groups of four or five. Our task was to estimate the number of smarties in a large box which was partially filled. A polythene cover allowed us to see into the box. A generous amount of time allowed us to complete the task and also to begin to understand the various contributions of individuals.

Each small group reported back to explain their estimate. Each of the three groups had differences in their approach, such that a combined effort of all three groups, acting as one, would have been a useful addition to the activity.

The general discussion considered assessments of individual performances within the group environment. Though interesting, they were too complicated to be entirely convincing. Imperial College reported being criticised in a HEFCE inspection for giving all students within a group the same score.

I was a bit worried that many colleagues appear to use group work more for summative assessment projects than for formative work in a supported environment. Though divided on individual assessment we were united in the need for students to reflect on the process.

Rating Student Achievement

We discussed the question of how to rate innovative maths assessments such as posters, project reports, and oral presentations. Ros Crouch of the University of Hertfordshire introduced the session. The group divided up and our reporter, Dr. Fahr, joined the peer assessment section. The discussion of students as peer assessors touched on several topics:

- working as a group
- expected outcomes and standards
- using examples of student work to test agreed criteria
- analyse and reflect, repeatedly.

An introduction to the use of a programme called FACETS was given. This is a pilot scheme for testing procedures for scales which measure each facet of student performance.

This workshop made me aware of the goldmine we are sitting on: students. Use them to assess their own work, so they learn as well as contribute

Comprehending Comprehension

This was brilliant. We were asked to read in small groups and make sense of a Guardian article. The subject was divorce statistics and we read it with a view to organising a comprehension task.

It took us a remarkable amount of time to sort through some very densely argued sums. These included ideas of large numbers, approximations, statistical significance, probability, sources of data, absolute and relative frequencies.

Finding questions to ask students about it was a very fruitful exercise. It was interesting to see the variety of responses between our groups. We were asked to evaluate our neighbours efforts.

The exercise reminded me of the variety of mathematics you can get as a spin off, if you ask students to read and make sense; that is, if you get them to look at maths which has been put in context by someone other than a teacher. I was also reminded how much better it is to write tasks for students with colleagues other than my own!

Assessing Assessment

The group looked at several aspects, including variation (small) in and justification for (varied) exam marking schemes; grid systems for assessing final year projects; and the problem of performance criteria, seen as training rather than education.

I was very interested in the Skills Audit in the Open University courses. It seems to be an effective way of making students aware early on of their difficulties and their successes. I will try it with my tutees next year.

Reflecting on Reflection

The session began with an OU video (staff development) showing students reflecting on their work with a spreadsheet, followed by a second video of two students reflecting on their work. Finally, an audiotape of dialogue between two students explaining (reflecting on?) how each helped the other.

This got us in the mood for thinking about reflection. Thereafter, we split into three groups to discuss:

1. Judy Goldfinch (Napier U)

We discussed how reflection might be incorporated into teaching. We used her example the STORM LP exercise (Page 5.21 in the assessment book of the package). Although really an assessment modification to ensure individual marks, it was agreed that there was some reflection involved.

2. Linda Hodgkinson (OU)

She posed four questions which were then discussed in her group:

- As practitioners, how do we define the term, reflection?
- In our professional work, do we use reflection?
- If we think it is a valuable process, do we provide opportunities for our students to engage in it?
- Do we assess it? Should we? How?

(See article on page 12)

3. Sylvia Dunthorne (City U)

Students produce a video, reflect on their performance, and produce a written report of the video (a critical appraisal really). Finally, they redo the video in the light of their report.

The group was asked to identify the processes involved (in students' reflection of the activity) which can be identified with maths processes. For example; stating assumptions, giving conclusions, appraising work, synthesising ideas, etc..

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Sybil Cock, University of North London
Fatimah Fahr, University of Luton
Mario Micallef, Warwick University
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MATHEMATICS

SUPPORT

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The next issue will be Christmas 1996.

The deadline for contributions for inclusion in the next issue is October 30, 1996.

The Math Centre at Minnesota University

The Math Center at General College at the University of Minnesota is a free walk-in tutoring center for our students.

General College (GC) is a developmental program for students who were not selected to attend the University of Minnesota. The students were not selected because of their grade point average in high school and/or the score they received on the ACT or SAT entrance exams.

Some of our students are adults returning to school after taking a break in their education. The courses taught at GC include some skill building courses, while others are transferable for credit towards a degree. The curriculum was developed to help these "at-risk" or "under-prepared" students be successful in a baccalaureate education.

GC enrolls about 800 new students each year. Students remain in GC for three to six quarters (terms) before transferring to a degree program at other colleges in the University of Minnesota, or other higher education institutions.

The mission of the GC mathematics program is to prepare students to succeed in college level mathematics courses and other courses where mathematics preparation is required.

The material covered in GC mathematics courses includes arithmetic, elementary algebra and intermediate algebra. All these courses are in preparation for college level algebra and pre-calculus.

The mathematics courses offered through GC typically are lecture courses that meet 5 hours each week. Although most of the 900 students enrolled in the GC mathematics courses are GC students, about one quarter of the students are University students who need review of their mathematics skills.

The Math Center is open 8 am–7 pm most days plus a few hours on Saturdays. It is staffed by 25 undergraduate peer tutors and the Math Center Coordinator. The tutors are hired by the Coordinator based on mathematics courses taken, tutoring style, and general "people skills."

The tutors work in the Math Center for 5 to 15 hours each week, and many also grade papers for the GC mathematics courses. Training for the tutors include a two-day pre-service training and weekly one-hour seminars throughout the school year.

> The mission of this program is to prepare students to succeed in college level maths courses

The Math Center consists of a large room with large tables for students to do their work. There are also some cubicles for students who need to focus their attention directly on their work.

The Math Center has seats for approximately 70 students. The number of students in the Math Center at a given time varies, so staffing reflects that variety, ranging from 2 to 5 tutors. The Coordinator also provides some tutoring, plus some of the math instructors spend a couple of hours each week tutoring.

Approximately 800 different students used the Math Center during fall quarter, 1994, most to do their homework. Tutors are not assigned to work one-to-one with students. The students work on assignments and raise their hand to ask a tutor for help when needed.

The atmosphere in the Math Center is one of working, studying, and learning, with conversations of mathematics throughout the room. Some hours the Math Center is quite full, so the energy is high, there are several conversations, and the tutors are very busy.

Other hours are not as busy, so there is a more relaxed feeling, but the students are still centered on learning. The Math Center is a support for the mathematics courses offered in GC. It is not intended to replace the mathematics instructor or attending class. Students are expected to go to class, read the text, and attempt the homework.

Because the mission of GC is to prepare students for college courses, we believe we need to help them in their learning and study skills. Therefore, tutors are trained to use questions when helping students. We do this to find out what students know, what they do not understand, and to help guide their thinking.

Some students have a difficult time when they are first tutored in this manner. Many expect the tutor to "tell them the answer," or to work the problems for them. Others think that the tutors are not knowledgeable because they ask so many questions. The tutors stress the importance of the student understanding the concepts, being able to apply them, and being able to develop their thinking.

Although the Math Center was created to provide support for GC mathematics courses, many students also ask for help in math-related courses such as physics, chemistry, logic, and statistics. GC students often return to the Math Center when they are taking University mathematics courses, even though the University mathematics department has its own tutoring center.

The variety of courses students ask questions about provides a challenge for the tutors. When a student is asking for help, the tutor does not know in what subject the question will be. The tutors need to be able to jump from basic mathematics to calculus to physics to statistics.

In the past, some students have felt uncomfortable seeking help from resources like the Math Center. To address that issue we have worked with mathematics instructors to provide many reasons and opportunities for students to come to the Math Center.

These include:

1) Make-up testing.

2) Materials for re-learning. (Students take a diagnostic test on the first day of class covering material from the previous mathematics course and are required to complete re-learning assignments on any problems missed on the test.)

3) Turning in homework.

4) Supplemental materials, including video tapes and computer tutorials that accompany the text or course.

For the past two years I have asked students in GC mathematics courses to complete a survey about using the Math Center. Survey results have shown that the Math Center is very helpful for most students. It provides added help and clarification of the material covered in the classroom. Some students commented that they would not have completed their mathematics course without the help they received from the tutors.

The reasons that students did not use the Math Center included

1) The hours and/or location were not convenient.

2) They did not need the help.

3) The student's other responsibilities (class, home, job) did not allow the time to use the Math Center.

An added benefit of the Math Center is the opportunity given the undergraduate students that work as tutors. The tutors not only receive financial help for their education, but they also learn a great deal and grow personally.

By working in the Math Center, the tutors increase their own mathematics skills, develop better communication skills, learn to work with a diverse group of people, and generally feel good about helping others. Some tutors who have become mathematics teachers have said this experience was of great value in becoming a better teacher.

The Math Center has been successful in providing support for many students to be successful in their mathematics and math-related courses.

Of course, there is always room for improvement so we continue to explore other ways we can support our students and instructors.

Susan Anderson
Math Workshop Manager
General College
University of Minnesota

A Poster for your Maths Workshop

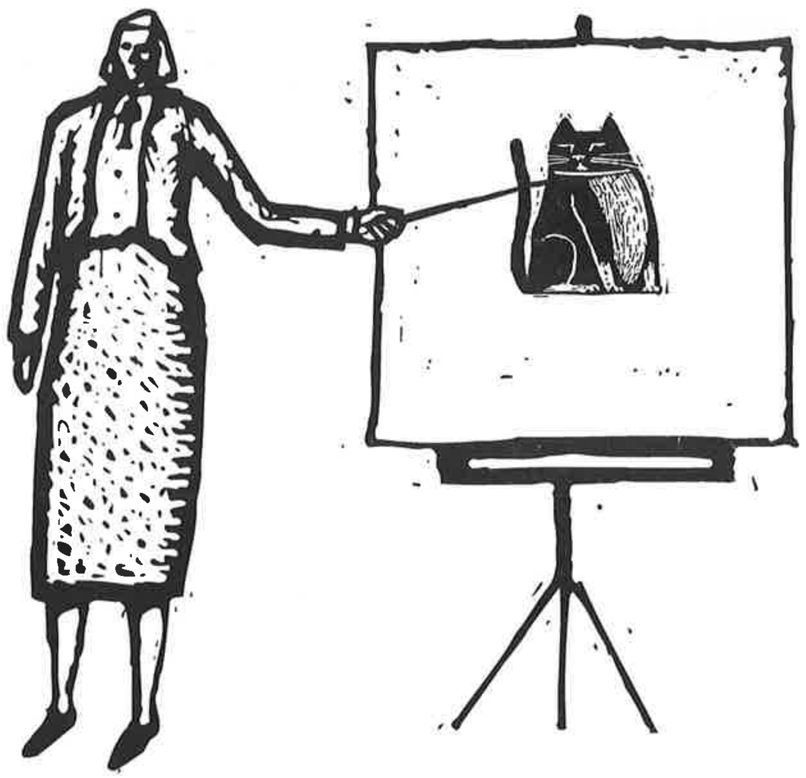
What Counts in Economics?

	V.Important	Mod.Imp.	Unimportant
Problem-solving skills	65	32	3
Mathematics skills	57	41	2
Connections	26	50	16
Research skills	16	60	23
Economics knowledge	10	41	43
Knowledge of the economy	3	22	68

All figures are percentages of more than 200 students in America's top graduate economics degree programmes, published in the Journal of Economic Perspectives. Each line adds up to 100% when you add in the "don't knows".

Engineering Maths: A Modern Approach

Andrew Fitzharris is a senior lecturer in mathematics at the University of Hertfordshire. He is Scheme Tutor on the BSc in Mathematics and is responsible for the day-to-day running of the mathematics courses on the engineering degrees. His academic interests include mathematical modelling, numerical analysis and computer simulation. He has used IT aids such as spreadsheets and computer algebra packages in his teaching for many years.



Abstract

There is an increasing number of students entering undergraduate engineering programmes with weak backgrounds in mathematics. This paper describes the measures used at the University of Hertfordshire for coping with these students and the attempts made to present engineering mathematics in an interesting and up-to-date way.

Introduction

There is a widespread feeling amongst staff teaching mathematics on undergraduate engineering programmes that the mathematical ability of the students entering these schemes has declined. This view has been confirmed by the recent investigations conducted for the Engineering Council (Sutherland and Pozzi 1995) and by the working party set up by the engineering and mathematics professional bodies (James et al 1995).

In 1992 an investigation was conducted on behalf of the School of Engineering at the University of Hertfordshire into measures for coping with students of this kind (Fitzharris 1992). The recommendations made in this report were summarised in the first issue of this newsletter (Fitzharris 1994).

Over the last 3 years many of these recommendations have been implemented and the engineering mathematics courses at the University of Hertfordshire have been redesigned to accommodate weak students and to incorporate many of the latest ideas in mathematics teaching.

Coping with the Changing Mathematical Backgrounds

To cope with the changing mathematical background of engineering students a wide range of supporting materials has been purchased. These include a variety of specialised textbooks, the cassette booklets produced by the Edinburgh Centre for Mathematical Education, the videos produced by South Bank University and Cap & Gown Ltd. and the CALMAT computer aided learning package produced by Glasgow Caledonian University.

The textbooks, cassette booklets, and videos, are available for student use in the main library and CALMAT has been installed in the Computer Centre. However, in the near future it is intended to move these materials into a Mathematics Learning Centre which is being created at the university. This is discussed in more detail in **Future Plans** at the end of this paper.

In addition to purchasing these materials, the engineering mathematics courses (across all disciplines) have been redesigned so that :-

• All courses contain an element of 'bridging mathematics' which is completed by all students before the main course material is covered. The material taught includes basic algebra, the solution of algebraic equations, the laws of indices and logarithms, partial fractions, standard functions and their graphs, elementary differentiation and integration, laws from data and simple curve sketching.

This material is taught in a variety of ways e.g. by student-centred learning using the supporting materials described above, particularly CALMAT, and by traditional lectures and tutorials. This approach has saved staff time and has encouraged the students to develop their study skills.

• All courses contain the same core mathematics subjects. These include further differentiation and integration, series, complex numbers, first and second-order differential equations, matrices and determinants and partial differentiation. The remaining subjects are then scheme specific. However, each subject had to justify its inclusion in the course i.e. if it was not required later in the scheme (e.g. in one of the engineering modules) then it was omitted.

To some, this approach may seem controversial as it could be argued that engineers should be equipped with the widest possible range of mathematical skills. However, the aim of the review was to produce courses which could be delivered comfortably within the time available. It was hoped that this would be beneficial for the students with weak backgrounds.

• Wherever possible, the material is taught in an appropriate engineering context. This has added interest for the students and has helped to persuade them that mathematics is a fundamental skill in all branches of engineering. On many occasions the engineering applications are used to introduce the underlying mathematics.

For example, for electrical engineering students, the idea of a second-order differential equation is introduced by applying Kirchoff's 2nd law to an LCR circuit. Following a discussion of the mathematical techniques required to solve an equation of this kind the students then return to the circuit problem to find and then interpret the solution.

• All first year courses introduce the students to a word processing package (e.g. Word), a spreadsheet package (e.g. Excel) and a computer algebra package (e.g. DERIVE or Maple). Wherever possible, these IT aids are integrated into the mathematical material.

The use of these packages has brought a number of significant benefits (Davies 1994) and (Davies and Fitzharris 1994). In particular, they broaden the range and the complexity of the engineering applications which can be considered and add interest and variety for the students.

• All courses contain a mathematical modelling component in which the students investigate open-ended engineering problems. For example, the students on the first year of the mechanical and aeronautical engineering degree are required to model the centre of gravity of a beer can as its contents are consumed (Oldknow 1993). The students are required to derive an expression for the height of the centre of gravity by taking moments about the base of the can, minimise this expression using both Excel and Maple and then produce a report of their investigation (including all equations) using Word.

Student reaction to the introduction modelling has been mixed. Many students need to be persuaded that the modelling process (i.e. the process of making simplifying assumptions and then obtaining the solution iteratively by gradually relaxing these assumptions) is worthwhile. However, the introduction of modelling has exposed the students to the type of problem solving activity they will encounter in their future careers and, in the report writing component, has encouraged them to develop their communication skills.

• All courses contain a significant amount of continuous assessment. The amount of coursework varies from course to course and ranges from 20% to 100% of the overall mark. The use of continuous assessment can provide students with a better opportunity to demonstrate their level of achievement (Sutherland and Pozzi 1995) and has allowed staff to examine skills which could not easily be assessed in a traditional examination (e.g. their ability to solve open-ended engineering problems like the one described above).

Many of the lectures on the new engineering mathematics courses are recorded in lecture theatres equipped with video cameras. No special preparations are made for these recordings. The classes are recorded exactly as they are presented i.e. in 'fly on the wall' style.

The video tapes are then stored in the resource centres within the School of Engineering so that they could be accessed by students who may have missed the lecture, not understood the content first time or simply require revision in that subject area. Although some members of staff expressed concern about having their classes recorded, the service has proved to be popular with the students who have made extensive use of the recordings.

Evaluation

The new engineering mathematics courses have only been running for one year and so it is too early to be able to draw any firm conclusions

Engineering Maths: A Modern Approach

about the changes. However, the student feedback in the annual questionnaire was generally positive and anecdotal evidence from staff has suggested that attendance and motivation have been improved.

Furthermore, the pass rates on the new courses were good. For example, on the mechanical and aeronautical engineering degree only 4 of the 140 first year students failed the mathematics course. This was a significant improvement on the previous year.

Future Plans

Developments in this area are ongoing. In the near future it is planned to :

- Redesign the mathematics courses on the science degrees in the same way.
- Develop a Mathematics Learning Centre at the university. This will house all of the supporting materials described earlier plus the equipment required to use them e.g. televisions, videos, cassette players, PCs, etc. The centre will be staffed full-time and students will be able to 'drop-in' and receive help whenever they have a problem.
- Introduce 'streaming' into the first year engineering mathematics courses. During the first week of each course all students will take a diagnostic test to determine their mathematical ability. In view of the large number of students involved, this test will be set and marked by computer.

The students will then be organised into two groups called 'standard' and 'fast' before beginning their first year studies. Both groups will follow the same syllabus and will take the same assessments. However, the 'standard' group will spend more time on the 'bridging mathematics' material while the 'fast' group will cover the remaining mathematics subjects in greater depth.

At the University of Hertfordshire significant progress has been made towards being able to cope with the changing mathematical background of undergraduate engineering students. However, there is still a great deal more work to do.

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E S L Computing[1]

First, the thoughtful, careful
Johann
Learnt of every key its function
Where the comma, where the
space-bar,
How the DEL key rubs out letters
(Letter-keys all qwertyfied);
Reading well the Students' Guide.
Need a new line? Press RETURN!

Next the bold and cunning Johann
Learnt with skill to drive a
package,
much encouraged by the manual
Being hard to understand,
For this meant the English
students
Had to work as hard as he.
Oh, that Life might easy be!

Last, the brave, ambitious Johann,
S P S S[2] learnt joyfully
(Rules for analysing data,
Thankfully, are language-free).
How to organise the input?
How to organise the output?
How to decode perfectly?

Hard the language of computers!
Hard it is to know the meaning!

"Run" he knows means hurried
footsteps,
As to lecture late he comes;
He has learnt in English lessons
Idioms, as "Bath–to run".

"Oh, computer, run my program,
Hurry, hurry through the steps!
Fill my output file with data,
Fill it up with problems solved!
Print my work for my admiring,
(Destined soon to be gold-starred,
By my student-friendly teacher!),
On soft paper, known as 'hard'..."

Hard the language of computers!
Hard it is to know the meaning!

Footnotes
1. ESL = English as a Second Language
2. SPSS = Statistics Package for Social Sciences

June R Pitcher

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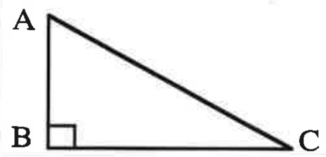
HOW THE NATIONS COMPARE IN MATHEMATICS					
Questions	Percentage answered correctly				
Selected questions by 14 year olds	England	Scotland	Germany	Hungary	Norway
$\frac{\mathbf{64 \times 0.3}}{\mathbf{0.32}}$	5%	4%	28%	51%	1%
Factorise $x^2 - 3x$	8%	4%	19%	34%	0%
Find the area of triangle ABC: Angle ABC is a right angle AB = 2m and BC = 5m 	57%	54%	47%	65%	43%

source: Exeter University

What percentage of your students understand place value, factorisation, or areas of triangles?

Assessing Mathematical Competence

DIAGNOSIS is a computer-based testing system for basic mathematics. It is a *knowledge-based* system, which asks the student questions appropriate to their background and adapts to their success on previous questions.

It has already been used successfully with over 1000 students in the North-East, and is being evaluated by over 50 universities, colleges, and schools, in the UK and abroad.

What does it test?

DIAGNOSIS tests a wide range of basic maths skills, from percentages and fractions through factorisation to simple calculus and statistics. There are 94 skills that can be tested.

How will it help you?

For any group of new students in sixth-form, FE or HE, you and your students will get off to a well-informed start.

- Each student gets a printed profile of their strengths and weaknesses.
- A ranked list reveals who needs special help.
- A group profile assists in course design.

The form of output may be customised with links to other resources.

Is it easy to use?

DIAGNOSIS runs on any PC, stand-alone or networked. It is quick to install and easy to use, with a built-in tutorial. A typical test takes about one hour. Processing the results is straightforward.

Many features can be easily customised to suit you and your students.

How does it work?

Underlying the whole test is a network of skills, with some depending on others. For example, expanding (x+1)(x+2) depends on being able to expand x(x+1). So a student who succeeds on the first of these need not be tested on the second, while a student who fails on the second need not be tested on the first. This means that only about half the desired skills need be tested - more efficient and less discouraging. Topics for years 7-11 of the National Curriculum are now included in the new version 1.3 (May 1996). Tests for other subjects using the DIAGNOSIS system, such as basic mechanics, are under development.

DIAGNOSIS costs £25 and is available to schools, FE, and HE.

TLTP Project

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Maths Support at Imperial College

Introduction

Several colleagues recently expressed surprise that an institution like Imperial College could have any problems with mathematics amongst its students.

But problems there are: whilst the entry A level total grade point average has held steady at high levels over the years, we can point to at least two changing factors.

First, the expansion in student numbers means that departments which used to insist on a good A level in maths, in addition to good grades in the "core" topics, no longer do so. For example, last year in the Chemistry Department about 20% of students had A level grade D/E or GCSE—an uncomfortable rump.

Second, if the value of A level as a whole is declining then the value of the high (A, B and C) grades must also be declining. Certainly we hear comments from colleagues that A level grade has ceased to be a reliable discriminant of maths ability.

The general "patchiness" of the A level now means that even superbly qualified students may have had no exposure to "advanced" topics like complex numbers, which have traditionally been set as prerequisites for some of IC's courses. (The fact that many such topics will not be in the A level "core" at all from 1996 onwards is a separate hurdle that places like IC will have to cross.)

The Mathematics Department at IC provides the majority of the first-year teaching of mathematics in the College. As a response to the school-university mathematics "gap", the Department has run for the last five or so years a Preliminary Mathematics Course (PMC), which operates informal tutorials for four afternoons a week for the first four weeks of the Autumn term, and is staffed by Maths Department lecturers and postgraduates.

Students come from all over the College, some are timetabled to be there for an hour or two, others "drop-in" because they have been advised to do so by their personal tutors; a few, presumably, attend out of personal initiative.

The original idea for our project was to provide computer-based materials to support the work of PMC, as well as to have materials and support available locally within departments.

The Transitional Mathematics Project

The Transitional Mathematics Project (TMP) was established in early 1993 with three years' funding from the Teaching and Learning Technology Programme [1]. We are a three-person team developing flexible learning modules for A level mathematics based around the computer mathematics system Mathematica.

Our modules were intended mostly for revision by way of self-study outside of timetabled classes, so we cannot require detailed training in Mathematica itself.

Our hope, then, is to teach mathematics with Mathematica, without explicitly teaching Mathematica itself. Can it be done?

The results of a formative evaluation carried out last year provide some answers to that question.

Structure of the modules

The module design has undergone several drastic revisions over the last two years, which you can read more about elsewhere [2]. The current design is, we think, a "publishable" if not a "final" one—we feel that nothing is ever really "final" in computer-based learning. Except for when the money runs out, the cycle of iterative design goes on.

The modules each have both paper and screen components: students work in a Mathematica Notebook on screen (which we have been inclined to term the "laboratory bench"), where we deploy both standard Mathematica functions and an additional set of specially-written functions (authored in Mathematica's programming language).

These support activity-centred mathematical explorations, termed Experiments, guided by Instructions for Experiments on paper, with traditional mathematical discussion available in the Background and Follow-up Reading.

Students, mathematics and Mathematica

There are many intriguing issues concerning the ways in which we want students to deal with the Mathematica system, for more detailed discussions of which see [2]. I'll mention two of them here.

First, there is our use of specially-written custom functions. We do expect students to deal with the full syntax of Mathematica, without any "softening" on our part, but we have chosen to provide some convenience functions, especially for graphical work, where there is a lot of sheer clutter in the standard syntax.

The results of last year's evaluation suggest that troubles with basic syntax were much less severe than troubles with understanding the graphical user interface to Mathematica (the Notebook document format), and our particular use of it as an instructional system.

The second issue concerns Mathematica's ability to perform most of the calculations involved in A level mathematics in a single step, without any intermediate work on the part of the user.

For example, algebraic manipulations and simplifications, solving equations, derivatives and integrals (it has been reported that Mathematica, unaided, scored 95% on a recent A level pure maths exam).

As the availability of powerful symbolic maths software increases (e.g. the latest TI-92 calculator from Texas Instruments has the Derive symbolic system built-in) we may expect that the teaching of such algebraic "method" skills will see a radical reform similar to that which happened for arithmetic in the age of pocket calculators.

However, for the time being (and no doubt for a long time to come), there is a need to "open up" calculations done with Mathematica to reveal the intermediate steps.

This is a hard problem: an idea we will be trying out, in the test case of algebraic manipulation, is to present mathematical methods (algorithms) as programs in the language of Mathematica which students will be asked to define and manipulate.

> Even superbly qualified students may have had no exposure to complex numbers

The 1994 evaluation

Our trials at IC in Autumn 1994 were evaluated by an independent researcher, whose report is available from us [3]. The evaluation focussed on a six-week trial with the entire first-year Chemistry class. Most had good maths grades but about 20% did not. So for most it involved revision of stuff done at school, but for the rest it was often new maths; thus our materials had a stiffer trial than we had planned for.

The evaluation found evidence that, all things considered, our materials do work, students learn some maths, and they enjoy the novel experience of doing maths on the computer. Human assistance in the computer lab was highlighted as being crucial; this is no surprise, but it's important to emphasise if only because administrators tend to view computer-based learning as very much a "teacher-free" activity.

Our materials clearly failed to provide students with a clear, consistent picture of the system they were using, what it could do, and what was expected of them. Our instructional system built on top of Mathematica, and Mathematica's own two-part structure (document interface and calculating engine) were seriously mixed up in the minds of many students.

The need to provide a consistent picture of "the system" is a general one, applying as much to a complex, programming-like user interface, as to a "friendly" point-and-click hypertext program.

Some future directions

We have secured four more years funding for 1996–99 by Imperial College itself—so we must be doing something right. Our brief has widened to look at the use of Mathematica not just in first-year but for courses at all levels, and to train both staff and students in the Mathematica system. To be, in short, an "expertise centre for CBL in mathematics".

We are looking into the following areas:

- Publishing the TMP modules commercially, as a textbook.
- Converting the modules to work also with the Maple system, which is commonly used in UK university teaching (more so than Mathematica, actually).
- A research project to investigate the human-computer interface issues when students use our modules: to look at the interfaces between the student's internal representations of mathematics, mathematics and its conventional notations, Mathematica and its own notations (the "human-mathematics interface"—HMI?).
- Ways in which the World Wide Web can be deployed as an environment for using powerful mathematical/scientific software, such as Mathematica. This has a particular bearing on the emerging interest in the "information superhighway" as an educational tool.

The original text of my conference poster can be viewed in full at: http://othello.ma.ic.ac.uk/articles/Luton.html

References

[1] Visit the TLTP World Wide Web site at http://www.icbl.hw.ac.uk/tltp/ .

[2] See three recent articles: "Mathematica for valuable and viable computer-based learning", "Highly-interactive Mathematica-based learning: philosophy, implementation and evaluation" and "From Instruction to Construction: computer algebra and the learner". All of these may be accessed at http://othello.ma.ic.ac.uk/articles/

or contact us for copies.

[3] Richard Noss, TMP/Transmath Evaluation Report, April 1995. Accessible at the URL http://othello.ma.ic.ac.uk/articles/EvaluationReport.html .

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Reflective Journals in Numeracy Classes

Introduction

"My students are quite good at thinking but no good at all at thinking about what they are thinking". Because they are not good at putting their thoughts into words, they have no way to examine and reflect upon these thoughts, to check them against later experience, to refine them and improve on them.

All of us, working on problems we can't immediately solve, have felt vague hunches and thoughts, just below the surface of consciousness. Words and mathematical symbols help us to get hold of an idea, so that we may then think about it. Often, the act of getting hold of the idea will enable us to get new ideas from it.

The honest use of words is an act first of self-awareness, and then of self-expression. "First we get hold of what we have inside; then we put it in such a way that someone else may share some of that feeling, experience, understanding." Holt (1970:177) concludes that writing and self-awareness come together and are not separate.

At last year's Adults Learning Mathematics Conference, at the University of Exeter, 14 delegates attended my seminar on the use of reflective journals in maths classes. They came from 7 different countries on 2 continents.

Most of us had used reflective writing in some way in our teaching of Numeracy. We also discussed exciting learning experiences that we had as students of mathematics, a question originally posed by Weissglass (1976:15). Those included insights which made sense of larger amounts of theory, analogous to finding a missing piece of jig-saw that allows further progress with the puzzle. Other exciting moments were discoveries made within the family or which applied maths to another branch of learning, such as Escher's tessellations. No-one mentioned a maths teacher as a source of an exciting moment.

If it is usually true that maths teachers' lectures do not provide many exciting moments of learning and that exciting moments are important motivators, then college maths teachers cannot continue only to lecture. What might maths teachers do to encourage those exciting moments to happen? How might they allow students to feel excited by them?

My thesis is that those students who are better able to notice and feel their successes learn more maths. Writing a reflective journal encourages students to look at their individual learning more dispassionately than when doing it and so notice more of those exciting moments.

Time is taken after each study session to look at the bigger picture of the learning environment and process. It only takes a little time for a student to stand back from the maths work and to experience the feelings of frustration and, crucially, of success. The feelings of frustration must be articulated to be healed just as expressing the successes develops this source of motivation.

Our own experiences of learning maths informs us that maths teachers who master the content of mathematics have only fulfilled a necessary but not sufficient condition to teach others. The learning process involves the whole person, which means providing tools to address affective as well as cognitive issues.

What is a Reflective Journal?

It is a diary which is entered every time mathematics work is done. Reflections are considered to be a part of the process of learning. Davis (1990:25) juxtaposes two dictionary definitions to produce a deeper understanding. She finds that reflect means to meditate, think back, or ponder and also to create an image. She then suggests the activity of thinking back to place yourself again into the learning situation (but safely in your imagination) in order to form an image of the experience. Capturing that image by writing it down allows speedy access to refresh memory and thence to look back at what was going on inside you, at the key moments, and at your behaviour.

At the University of Luton, reflective journals are required on all the Numeracy modules for primary school teachers. At level 1, it is suggested that they are used principally to document feelings encountered in class or while learning mathematics at home. In addition, students are asked to think about how they learn.

At level two, a more applied approach is expected and there is a specific requirement to generalise ideas derived from learning into ideas for teaching. An emphasis on a self-dialogue about mathematical ideas is requested by way of preparing students for level 3. Moreover, students are asked to 'reflect on their reflections' to notice if there have been changes in perceptions occurring over a period of time, (see page 14 overleaf).

Students in level 3 are confronted by more open ended problems and their growing ability to reflect is oriented now to problem-solving tasks. Reflecting is often neglected though considered to be an integral part of the problem-solving process by Polya (1957:14) and by Mason (1985:42).

Numeracy Modules for Primary School Teachers

Support staff and nursery nurses in primary schools in South Berkshire, North Hertfordshire, and Buckinghamshire have been sponsored by their individual schools to study for a BA. in Educational Studies on a part-time basis. All intend to become primary school teachers.

This scheme offers a career opportunity for mature women who are currently often running classes for close to the minimum wage in part-time jobs.

One school will sponsor only one person and mostly they have chosen experienced people. About half the 60 support staff on these courses had taken maths at O level or GCSE Higher and most had not studied it recently. There was great anxiety about the Numeracy modules by all the students.

The students in the Numeracy modules have used these journals to explore feelings, to document homework, and to communicate personal issues affecting their ability to learn.

Difficult concepts were thrashed out in the journals and successes savoured when insights occurred. Those students who 'developed a relationship' with their journals were motivated by a large number of insights and breakthroughs in their understanding of problems that they themselves identified.

> Feelings of frustration must be articulated to be healed

Some students used the journal to complain about the course, me, maths; and that presented a difficulty as the journals were an assessed part of their work.

The dilemma I face is that I feel that students won't give reflective writing a chance unless it is assessed while serious reflection requires the student to write openly and this requires safety. Julian Weissglass' students at the University of California were able to make better use of writing a journal when it was not assessed. He wrote in a letter to me in March 1996:

"In terms of assessment, all my experience leads me to believe that external grading distorts the learning process and increases the distress level of students. I haven't yet seen a student who was not anxious about grades whether they were working for a group grade or for an individual grade even when the assessment was friendly and informal."

I had attempted to encourage openness by openly requiring an honest attempt to think reflectively about mathematical learning experiences. I now face institutional pressure to present well-defined assessment criteria and pressure from students to be more clear on what is required of them. The grid of assessment criteria which follow is the result (page 14).

Wide-World Influences

Theoretical justifications for asking students to do such an apparently unmathematical activity as reflective writing are to be found in many diverse places. Writing as an aid to thinking has been argued by Bruner (1966). Piaget (1928) and Skemp (1986:51-63) have written about the importance of reflection as a process within the psychology of learning, and particularly in theories about problem-solving and about counselling clients in problem-solving situations.

More recently, von Glaserfeld (1989:121-140) has built a superstructure on Piaget's ideas arguing that learning necessarily requires individuals to reconstruct the ideas of others and to constantly deconstruct and reconstruct those ideas as new evidence appears.

Weissglass (1994:67-78) offers constructivist listening as a tool to help others reflect successfully and in safety. Weissglass' conclusions are supported by VonGlaserfeld, though they derive more from the co-counselling theory of Jackins (1971).

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Holt, J. (1970) *What Do I Do Monday?* Dell Publishing Co. Inc.

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Mason, J., (1985) L. Burton and K. Stacey, *Thinking Mathematically* (2nd ed.). Addison-Wesley, Reading.

Piaget, J., (1928) *Judgement and Reasoning in the Child.* Routledge & Kegan Paul, London.

Polya, G (1957) *How to Solve It – A New Aspect of Mathematical Method* (2nd ed.). Princeton Paperbacks.

Skemp, R. (1985) *The Psychology of Learning Mathematics* (2nd ed.). Penguin Books, Middlesex.

von Glaserfeld, E., (1989) *Cognition, Construction of Knowledge and Teaching.* Synthese 80 (July)

Weissglass, J., (1976) *Small Groups: An Alternative to the Lecture Method.* Two Year College Mathematics Journal (now College Mathematics Journal) 7:15-20.

Weissglass J., (1994) *Changing Mathematics Teaching Means Changing Ourselves: Implications for Professional Development.* Professional Development for Teachers of Mathematics: 1994 NCTM Yearbook.

Ian Beveridge

University of Luton

Reflective Journals: Assessment Criteria

Level 1

CRITERIA	A GRADE	D GRADE
Mathematical Thinking	Articulating arithmetic algorithms; Comparing alternative algorithms and identifying appropriate use of them; Problem-Solving strategies; Use & Meaning of Symbols; philosophy of mathematics.	Writing for understanding; talking maths; processing new concepts; Creating meaning (eg. for fraction algorithms); Identifying insights; Documenting newly learned understanding of previously learned and automatised routines.
Collaborative Learning	Identifies conditions for effective communication; Identifies suitable activities for this environment; Insights on the sociology of small groups; Reflections on the changing of group composition.	Actively appreciating others; Small Group management skills; Limits of usefulness of small groups; Composition; Comparing self and others; Observations of key moments.
Language Issues	Observing language issues in the maths classroom; Distinguishing between oral and written language skills; Insights into language and symbolism; Ideas about the metaphor of maths as a language.	Distinguishing between maths and everyday meanings (of concepts such as 'negative' and 'zero' and 'average'); Attention paid to childrens' language to express maths ideas; maths vocabulary lists.
Personal Development	Visualising self as confidently teaching maths; Introspective narrative; Appreciation of Successes; Limits and strategies to cope; Integrating teaching and learning issues; Relating issues of intellect and affect; Follow up class ideas with own work.	Learning to ask for help; Descriptive narrative; Expressing frustration and observing its effects; Showing understanding of self; Changing attitudes over duration of module; Trying out some ideas from class but without altering the material.

Level 2

CRITERIA	A GRADE	D GRADE
Mathematical Thinking	Tenacity in sticking with a problem; Problem-Solving strategies; Evidence of Specialising & generalising; Use & Meaning of Symbols; Translating between different representions; Philosophy of mathematics.	Writing for understanding; talking maths; processing conceptual ideas; Creating meaning; Identifying insights.
Independent Learning	Generalises from own learning to that of others; Addresses the limits of personal ability to give and receive support for independent learning; Critically evaluates the quality of material.	Identifies where support is needed; Builds a support network; Organises questions for further clarification.
Teaching Issues	Ideas integrating maths into the wider curriculum; Importance of lesson structure; Ideas about dealing with the 'chicken & egg' issues where order of presentation is a problem; Ideas about what composes learning, assessing assessment, creative maths.	Observing teaching critically; Development of ideas about teaching from own learning; Ideas on 'warm-up' activities; Differentiating different learning styles.
Following Up Class Activities	Developing new materials; Testing them out with children; Reflecting on lessons learnt as a procedure for development; Finding out about the ideas of others in field of maths teaching.	Adapting existing materials and devising extension activities; Reading up on ideas of interest or on ideas that are not immediately understood; Processing difficult ideas and monitoring progress.

CONFERENCES

MCHE1

Mathematics Counts in HE
4 July 1996
Nene College of HE
Contact: Jacqui Dennison
Tel: 01604 735500 x3145
e-mail: jacqui.dennison@nene.ac.uk
Cost: £68 (£98 overnight b&b)
Themes: IT and maths; curriculum, social, and political issues; innovative practice; support issues.

ALM3

Adults Learning Mathematics: A Research Forum
5-7 July, 1996
University of Brighton
Keynote: Mary Harris, "Women, Mathematics and Work"
Contact: S Grover
Tel: 01273 642501
e-mail: s.grover@brighton.ac.uk
Cost: £145 b&b (£60 daily rate)
Themes: research into adults, mathematics, and related teaching and learning issues

DERIVE

Exploring Maths with Derive: a hands-on workshop for teachers
8-9 July, 1996
Suffolk College of FHE, Ispwich
Contact: David Bowers, Mathematics Workshop
Tel: 01473 296339
Fax: 01473 230054
This two-day course is for teachers without experience in Derive. A grounding in its essential facilities is given, with advice from experienced practioners of computer algebra, for teaching and assessment. Each participant works on their own PC in a small group.

CTImathsworkshop

Using Graphics Calculators with 16+ students
10 July 1996
University of Birmingham, Edinburgh
Contact: Pam Bishop
Tel: 0121 4147095
Fax: 0121 4143389
e-mail: ctimath@bham.ac.uk
cost: circa £30
Themes: a variety of workshops and speakers from across the FE/HE phases.

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

CTInetwork

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>

FEmathsworkshops 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

Mathskills: Maths Discipline Network

Provides information and support material to the maths community through its web page:
URL:http://www.hull.ac.uk/mathskills/
Contact: Dr Ekkehard Kopp
Tel: 01482 465876
Fax: 01482 466218
e-mail: p.e.kopp@maths.hull.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

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.

News from the Internet

Introduction

Nervously, I entered Luton's cybercafe, to order a coffee and one-half hour of instruction about 'cyberspace'.

For some reason, 'navigating' the Internet terrifies me and I wanted someone to hold my hand. I typed in 'maths-support' in a box at the top of the screen. There was a network entitled 'maths-support' on a server called Mailbase.

I clicked my mouse and received information about other support networks on the same server. An intriguing entry was, "Innovations in Student Learning". I 'lurked' in on a discussion on mathematics teaching.

The next day, Sybil Cock sent me this copy of that discussion, initiated by Bland Tomkinson's question and which I have edited.

Bland Tomkinson
CBTOM@sdú.umist.ac.uk

Does anyone have any ideas on innovative teaching of mathematics?

Neil Challis N.Challis@shu.ac.uk

We at Sheffield Hallam are teaching mathematics to a wide range of students, both maths students and others (Engineering, Construction, Science, Computing, Education...).

We are currently undergoing a period of major curriculum development, thinking about and implementing changes which become possible given the current advances in technology, changes in curriculum content, assessment style, teaching style, and student learning style.

We are (amongst other things)

- making substantial use of technology in teaching, not particularly CBL although I am one of the Mathwise authors, but hand-held technology such as the TI-85, and spreadsheets.
- designing problem-based units in mathematics and modelling
- getting students to use learning diaries as a reflection tool
- encouraging group work
- using case studies as a medium for teaching mathematics
- experimenting with different ways to use large group classes (lectures!)
- integrating the teaching of mathematics with IT and communication skills, as well as putting emphasis on student reflection and explicitly addressing the issue of independent learning with students.

Tom Panitz
TPanitz@mecn.mass.edu

There have been a number of discussions going on about cooperative learning in maths and other areas. I think the most effective approach to teaching maths is to have students work together in pairs on any assignment you would normally give to individuals, and I would have them work in class in pairs. Working in larger groups can provide new and different experiences and make the class more interesting. In groups of 4 people tend to break down into pairs unless you have a very organised and directed activity that encourages them to stay in a '4 group'.

As a starting point teachers could give a short presentation of 10 minutes and then assign pairs a few problems to work out to see if they understood the lecture. Then return to lecturing for another 5 minutes and give problems again. After each lecture/work session, ask the students to put their problems on the board. They can do it in pairs if they wish. Ask for explanations of process by the pairs to be sure everyone has the concept. While they are working in pairs the teacher can walk around and observe what is going on, make suggestions or refer pairs to other pairs for help.

Anything you can do by yourself is more fun in pairs.

Trevor Habeshaw
J.T.Habeshaw@ex.ac.uk

It's always a good idea to start with "53 Interesting Ways to Teach Mathematics" and "53 Ways to Ask Questions in Mathematics and Statistics". They're all available from TES Ltd so call Plymbridge Distributors on 01752 695745 or fax them on 01752 695699. They actually tell you what to do.

I start by encouraging students to use the DIY exercise in our book "Interesting Ways to Teach - 12 DIY exercises", pages 73-79, which insists on considering a selection of issues together according to an organised structure. These DIY exercises work. Typically the result of the exercises is that at least some of the mathematicians reconfigure their "field" having taken part in an exercise about which they were initially sceptical (some highly so) but they accepted it and could see a different future.

Anon@Anon.ac.uk

At ***** the only acceptable innovations would be bigger blackboards, more chalk and ambidextrous staff. However, you may care to consult the PCFC project, "Teaching More Students" , (Gibbs et. al. 1992) especially volume one, "Problems and Course Design Strategies". There's an interesting case study in mathematics teaching described on page 67 although all of the volume is instructive.

Adele Graham
a.graham@auckland.ac.nz

I am on study leave in Hong Kong, on my way to Scotland, so I cannot be too specific but there is some excellent work happening in Stage One statistics at the University of Auckland.

I suggest you contact Bill Barton or Maxine Pfannkuch at the School of Maths and Statistics.

John Malone
malonej@info.curtin.edu.au

Greetings from Perth, Western Australia. Someone passed onto me that distressing call for assistance you made regarding the need for some ideas on innovative mathematics teaching. You have probably the foremost places to give you this advice in your own country. I am sure that a call to the Shell Centre for Mathematics Education in Nottingham would bring some quick assistance, or a phone call to Leone Burton at the Uni of Birmingham would get results too.

Sybil Cock S.Cock@unl.ac.uk

As well as the SEDA publication mentioned by Ivan Moore, which is excellent, I have just seen advertised and ordered (it has yet to arrive) the following:

Maths Learning and Assessment Pack edited by Chris Haines and Sylvia Dunthorne (City Univ.) ISBN 0 34064576 8, more information from s.dunthrone@city.ac.uk or c.r.haines@city.ac.uk. It looks good and costs £50.

The problems you describe are very familiar to me in my position here. Are your mathematicians teaching mainly maths students or is it "servicing work"? At the University of North London, I have found that a very high proportion of undergraduates take maths in some form or other but the staff tend to focus on the needs of the specialists only. The recent big debate on "falling standards" has also had an impact—not very constructive-as it reinforces tendencies to blame students for failure to learn!

We are doing a nice experimental supported open learning delivery for an entry level maths unit—we are writing it up properly but I can give you more information if you want.

There is also a maths support section of the new electronic magazine Deliberations (see page 23 of this issue).

A few other things: there's a mailbase list called maths-support on the server MAILBASE—not very active at the moment but with over 100 members recruited within a fortnight of its start. Ian Beveridge at the University of Luton edits a twice yearly newsletter MATHS SUPPORT dealing with issues in this area - worth getting hold of on 01582 34111 x 2519.

Paul Strickland
P.M.Strickland@livjm.ac.uk

My own interest is in computer-aided self assessment, whereby a student can attempt exercises at a PC and get immediate feedback for errors. The approach differs from CALM etc. in that rules are used, which means that topics such as equations and integration can be covered. You can obtain a demo version from my home page:

http://www.cms.livjm.ac.uk/www/homepage/cmspstri/index.htm

Sally Davis
sdavies@blackwellpublishers.co.uk

Computer based learning offers students the opportunity to work at their own pace and to see animated presentations.

If you are teaching to non-specialists, you may be interested to see the WinEcon package. This includes two chapters on maths, intended for economists but possibly of interest to anyone trying to learn to use differentiation, (see page 5 of this issue).

Mick Farmer
mick@cs.bbk.ac.uk

Some time ago I saw a technique for learning equations through the use of a spreadsheet and associated graphics. The user could experiment with different input values and the package automatically updated the output values and graphs. Unfortunately, I cannot remember any reference!

W.Cox w.cox@aston.ac.uk

I am seconded half-time from mathematics to academic staff development adviser, here at Aston. I have used a range of methods for maths teaching, including open learning, problem centred learning, etc. My philosophy has always been to match the teaching/learning strategy and methods to the educational objectives and the learning environment. And, as you observe, chalk and talk is not always (but it is often) the best approach.

One particular line that I have taken is to encourage the students to develop the material for themselves, guided by carefully designed exercises which lead into, rather than follow on from, the text ('ask and answer' rather than conventional 'tell and test') This is the approach adopted in my recent book on Ordinary Differential Equations, published by Arnold.

Incidentally, is there anyone there interested in the school to university transition problem? I convened the Mathematical Association's workshop here at Aston on 2 April to look at possible solutions.

Ivan Moore I.Moore@ulst.ac.uk

SEDA (Staff and Educational Development Association) has an excellent series of publications called "Innovations in Teaching". Innovations in Mathematics contains 18 case studies from all over the UK (SEDA paper 87). For £8.50 and the cost of a stamped addressed A4 envelope, you can receive it from: Jill Brookes, SEDA Administrator, Gala House, 3 Raglan Road, Edgbaston, Birmingham B5 7RA.

See Sybil Cock's column on page 23 for instructions on how to join this discussion forum.

Basic Maths Resources Handbook

Peter Samuels, Maths Support Assoc.

The purpose of the handbook will be to assist lecturers and other staff involved in basic mathematics education in Further and Higher Education to select and implement resources which will enhance any aspect of their teaching by non-traditional methods.

Its emphasis will be on resources from an *educational perspective,* rather than a technical perspective. It will be more than simply an information resource. The idea will be to extend the existing social network based around the Mathematics Support Association and the maths-support electronic mailbase list by providing a more long-term, objective, focus for the social networks than the existing newsletters, conferences, and discussion forum.

In order to achieve these educational objectives, the handbook will contain details of how resources can be and are currently being used within curricula (courses of study). The purpose of this will be to *promote excellence* both in the selection and implementation of resources.

This dual purpose will be expressed by giving details about resources and by providing expertise in how to implement them including case studies of good practice and wider issues such as advice on how to run math workshops.

The handbook will not be selective in terms of the media of the resources (e.g. text, video, computer etc.) or the educational method they employ or the stage or degree within the educational process in which they are used (e.g. primary resource, secondary resource, assessment instrument etc.).

However, it will be selective in terms of focusing entirely on the education of basic mathematics (including areas such as Numeracy, basic statistics and pre-calculus algebra) and the inclusion, status and length of references to resources will be in accordance with the judged educational value of the resource (in terms of criteria such as its intrinsic educational quality, current or potential scale of use and significance within the educational process such as might be determined by its breadth and depth of content).

The process of evaluation of resources will be distributed as widely a possible through the Mathematics Support Association and the maths support list. This will be achieved through the initiative and administration of an *organising committee.* This process will form the social basis for the dissemination and use of the handbook itself by means of awareness, ownership and shared values.

Attention will be paid to the appropriability of resources including the required shift in educational philosophy from current traditional practice (e.g. implementing self-paced learning) and resource implications (e.g. staff time, space etc.) both for the implementor and those in authority over them within their institution.

Advice will be given as to how to make these changes which again will be grounded in the existing social networks by involving people currently engaged with these issues. Attention will also be paid to special needs, adult learning, and providing equal opportunities.

The handbook itself will be based on existing good models such as the following references:

[1] P. Bishop, Maths & Stats Guide to Software for Teaching. The CTI Centre for Mathematics and Statistics, University of Birmingham third edition, 1995

[2] A. Grove, Mathematics for the non-specialist: A survey on behalf of the Open Learning Foundation. Technical report; The Nottingham Trent University, 1993

[3] Learning Technology Dissemination Initiative, Information handbook, Heriot-Watt University, 1995

[4] A. Fitzharris, Learning resources development fund project: Final report. Technical report, Division of Mathematics, University of Hertfordshire, 1992

Second Maths Support Association Conference

The conference was opened by Dr Wood, Vice Chancellor of the University of Luton, who recalled the details of an outspoken article he wrote to the THES about declining skills when Head of the Maths department at Nene College.

Ros Sutherland, the opening speaker, reported her findings on the backgrounds of students entering HE. In the light of the Cockcroft report (1982), algebra has been embedded in familiar contexts, and pupils have lost the ability to manipulate symbols confidently.

The conference sought to encourage dialogue. David Bowers of Suffolk College and Sybil Cock of Univ. of North London ran seminars on drop-in maths workshops. Jeremy Levesley of Univ. of Leicester and a student demonstrated SI as a peer support programme.

Peter Samuels, Univ. of Newcastle, demonstrated the new TLTP diagnostic programme. Malcolm Swan of the Shell Centre opened a discussion on teaching GCSE as a diagnostic teaching experiment.

Viv Ferguson of Cheltenham & Gloucester presented a successful college-wide numeracy module. James Wisdom of SEDA entertained us with his research into student perceptions of maths as it is taught (see facing page).

Finally, Peter Samuels defined the task of compiling a Maths Resource Handbook. The survey accompanying this issue attempts to define current practice.

What Do Students Say about Maths?

Students' problems

Business Studies students felt that in Maths the standard required was far higher than that specified in the prospectus—even students with "A" level maths were finding it hard and those who had last done it at GCSE probably had no maths in the last two or three years. There was too much work to cover in too short a period of time. The tutor moved on before students had understood a topic. The tutor always asked if people understood and they stayed silent.

Electronics students found it hard to follow maths lectures; some of the explanations were not clear and were based on the (false) assumption that the students already knew sufficient maths. They thought this subject needed more time and more concrete examples of applications in the field of electronics.

Accountancy students thought they had been dropped in at the deep end; the course started at a high level. It was particularly hard for those who had not done maths for a while. Could they be given material, book lists, preparatory exercises etc. before the course starts?

For some students, the feedback from the mid-sessional tests was the first warning of their problems in this area. Why won't lecturers recap a lecture's key points at the start of a tutorial to make sure students understand? As with electronics students, concrete examples in their field were lacking.

Geology students also suffered from a pace of presentation in lectures beyond their ability to keep up and that in the first year. They wanted to be shown how to deal with problems, not just theory.

Chemistry students thought there was a definite need for more mathematics because there was a wide range of abilities and experience in the class. They felt there was too much content and no depth to any of it.

Final year Estate Management students were surprised by the stress of 'valuations' in their course. They had not understood the prospectus when it said it was a 'valuations based course', as they had never come across this term before. They had not been aware just how important maths and numeracy were going to be. Some felt it was a matter of confidence, some that it was a matter of maths skills, and some that it was a matter of 'a maths mind'.

Radiography students had lectures in a very large class where it had been hard to hear and see. The technique of putting up small portions of the overhead transparencies had not been very successful. There was no time for any form of student interaction -

they would have preferred smaller classes and individual teaching. They suggested that they first work through a section of the textbook and then use lectures to consider problems arising. Again, examples specific to their discipline were in short supply.

Management students said they were expected to know statistical analysis in great depth but they had neither the time to learn it nor to apply it. They were taught perhaps five ways of doing something but, in their minds, none were required because computers were able to do the work. They found it very difficult to relate the content to real life and were really unsure about why they were doing it at all.

Students' solutions

- cut down on content
- provide tutorials
- stream classes
- intensive teaching (during inter-semester breaks?)
- self-teaching packages
- more class contact hours
- two-way communications with lecturers
- maths workshops
- remedial packages
- diagnostic tests
- optional foundation courses
- peer tutoring
- more discussions
- conjecturing atmosphere where it's safe to ask questions.

Signs of success

Teaching maths as a way of thinking: Music Technology students thought their maths was taught well and that it would not properly be included within other units. It was described as giving the feeling of another way of using the brain.

Starting from scratch: Economics students had experienced a lecturer who built up their confidence and relevant knowledge by explaining everything from scratch. The lectures were helpful, especially with the published lecture notes and exercises. The seminars worked well and the revision classes had a 'trampoline' effect if a student was in difficulties.

Good Teaching: Civil Engineers, when asked for an example of good teaching practice, had cited their maths lecturer. This person had shown great patience, gone at a good pace but from simple principles to the more complex. The lecturer was especially clear, had given good back-up tutorials, and had left the students with "a good set of notes".

There was also an understanding of what level of knowledge to assume at the beginning (quite low, we were informed by an ex-HNC student) and had made a real attempt at levelling up. Didn't this make it dull for those starting at a higher level? Not at all, apparently those students saw the whole experience as useful reinforcement.

James Wisdom, Head, Educational and Staff Development, Educational Development and Support Service, London Guildhall University.

Reading Technical Material - An Important Study Skill

Students have been taught to read—taught to read too fast to take in the meaning of technical writing. By technical writing, I refer to:

• Long sentences, with relative clauses and embedded subordinate sections, and paragraphs in which sentences refer to each others' contents in a complex way. Many examination questions illustrate this.

• Sentences densely packed with meaning; these may be quite short. For example, a computer manual contained the statement, "Period terminates command". Many students have neither the knowledge of the meaning of words nor the interpretative skills to find out that this means, "The computer won't do what you want until you signal you have finished giving the order by typing in a full stop."

• Sentences with several obvious technical words or phrases, whose precise meaning in the context you must know in order to take in the message. I emphasise "in the context"; you can get in a real muddle with the wrong technical meaning of "normal".

• Sentences with everyday words used in a precise technical way, often not suspected by the student, who may be quite happy with, say, "discharge" with a meaning of "go away" and never really get the hang of electrochemistry.

We need to help students deal with complex written material. What can we do?

• Both in speech and class handouts, draw attention to technical words, particularly the everyday-language traps.

• At some appropriate point (every lesson?) give the students a little practice in teasing out the meaning from complex written information. (This includes on-screen guidance for software packages - often cryptic.)

• A good class exercise is to give the students some interesting, but complex, material, to read in pairs, explaining each sentence to each other. If necessary, the lecturer acts as consultant and dictionary. This often results in a marked improvement in textbook reading.

• At a later stage, each pair of students has two articles from a technical journal. A student reads one article (10 minutes thinking hard and taking notes) and has 5 minutes to tell the partner student about it. This may produce quite lively dialogues, if you are cunning about choosing a pair of related passages on something in the news. Oh yes, and the students are practising a transferable skill!

Some spin-offs to improved reading-for-study are:

• better note taking

• easier conversions of examination questions into the traditional What am I told? What is the aim? What is a suitable approach? form.

Perhaps some tutors reading this may think their students are not in need of this kind of help. Are you sure? You never hear a student complain, "The manual doesn't make sense", or, "I could do the question if I could find out what it means!"

I promise I am not making this up: I discovered that a significant proportion of students were checking a course evaluation form statement, "I found the course thought-provoking" on the assumption that "thought-provoking" had the meaning, "really annoying".

June R Pitcher,

University of Luton, Department of Mathematics & Statistics

Algebra

Sometimes Algebra can be a nightmare for me. I ran out of an Algebra class last autumn, after a quiz, because I did not want the whole class to see me crying. I managed to hold back my tears until I reached the women's toilet. Then I wept, feeling about eight years old, ashamed and humiliated.

It was a quiz on logarithms which had unseated me, reverting me to a childish state. The maths teacher had also reverted, becoming, in my imagination, the one who used to throw the board rubber at me when I was a child and I could not add a simple column of figures. The first time this had happened was after I had tried to explain to him that, if I knew what the numbers were, I would be able to add them up. He was unable to understand that I was trying to verbalise an inability to comprehend the abstract, concrete person that I am.

I left the toilet and walked across the park, over to the sculpture gardens. Despite the sweet, crisp, sunny early November morning, the dew-speckled dead flower heads and their brown leaves and stalks, representing the death of Summer, filled me with melancholy. I was filled with self-recrimination. If only I had understood maths all those years ago, I might have gone to University with my contemporaries. I would not be struggling now to comprehend new concepts. Self-pity washed over me as I wept.

I crumpled a few dried leaves of Russian sage between my fingers and inhaled their scent. Gradually the sweet aroma soothed me, returning me to my senses. I put down my heavy book bag and lay down on the grass, allowing the weak November sunshine to caress me. Stuffing some of the sage into my pockets as a talisman for the future, I slowly walked back to school, determined to understand logarithms, no matter what it would take. I would see a tutor. I would review the material with the teacher. I would practice until I got it.

I took some of the sage into the final exam. The scent of it calmed me whenever I felt the old, familiar, panic rise. I would close my eyes, take a few slow, deep breaths, and tell myself that I could do it. And I could do it. Taking the final (exam) felt like skating over a frozen lake; cautiously, carefully, looking out for cracks in the ice, stumbling blocks to trip you up. Remembering to breathe, concentrating, gliding slowly through it; paying attention, yet letting go. Navigating through dangerous territory, patiently, step by step. And arriving, triumphantly, at the other side.

Cilla Walford was raised in Walberswick, Suffolk, and now attends, as an adult learner, Minneapolis Community College.

Asking Open Ended Questions in Adult Numeracy Classes?

A maths problem is open-ended if it meets one or more of these three criteria:

1. there is more than one way to solve the problem;

2. there is more than one answer to the problem; or

3. the problem requires the student to interpret the question or to make a value judgement.

These types of questions change the teacher's role from being the absolute authority (the one who has the answer key) to being a facilitator of mathematical exploration. Therefore, solving open-ended problems can be used to build the students' self-confidence. The NCTM Standards urge teachers to encourage their students to develop their own mathematical power and open-ended questions can provide that opportunity.

By asking students to solve open-ended questions and share their solutions in the classroom, four of these standards can be practised. Students can learn from each other without having to discount their own answers to help them expand their repertoire of problem solving skills.

By explaining their answers, students can develop their ability to reason and communicate mathematically. Open-ended questions also frequently ask students to draw on their past mathematical experiences and connect their knowledge in other subject areas to maths.

So where can an over-worked Adult Education teacher find such problems? Sorry, you'll have to write them yourself. But it's not impossible and not even too time consuming! For example, you can start with a standard word problem:

Joe bought a turkey for £8.34 and a chicken for £4.17. How much did he spend on meat?

(a) £2.00 (b) £4.17
(c) £12.51 (d) £34.78
(e) £20.00

One way to open up this traditional problem is to rewrite the question so that the student starts with what had been "the answer". Then the original problem becomes one of the many possible solutions. For example:

Your budget allows you to spend up to £15.00 for food each week for each family member. Using this week's grocery store flyers, make up your shopping list and calculate exactly how much YOU would spend.

Asking students to share their solutions to this problem offers the opportunity to connect mathematics to other subjects; for example, nutrition. Or other cultures could be explored as students explain to one another the types of meals they prepare.

Students will also have the opportunity to connect this problem with the maths they use every day. The problem could also be used as an opportunity to develop and connect the students well developed concepts of budgeting to mathematics.

The same trick of posing "the answer" as the question works with all ability levels. Instead of pages of meaningless two digit long division calculations, ask the student to choose from a hat containing 3 or 4 digit numbers to use as the dividend and from a 4-digit numbers hat for the divisor. Then ask the student to write (or tell) a division word problem using those numbers and solve it on a separate paper.

When the student exchanges problems with a classmate and solves the other's problem, there is a lot of opportunity for expanding the student's mathematical communication skills. Or if the class is more advanced ask, "describe a situation in which you would use ratios to solve a problem."

Having students share when they apply various problem-solving strategies encourages students to be independent problem solvers and hones their mathematical reasoning skills.

A word of caution before you jump right in; prepare your students. Explain what an open-ended problem is and why you think it's valuable for your students to be able to solve them. The most intriguing open-ended questions will fall flat if the students' definition of mathematics is rote worksheets. Also remind them that it takes practice. Both the students and the teacher need to get used to their new roles in the maths classroom.

Sally Spencer

Massachusetts Adult Education

Adult Numeracy: Confidence in Maths and Multiplication Tables

There is national concern about the level of Numeracy both in industry and amongst undergraduates reporting a lack of confidence and a fear of mathematics [1].

Research suggests that confidence has a basis in experience, negative experiences having an effect on a child's motivational orientation, academic self-concept and self-esteem within that subject [2].

A Keyword survey carried out in Plymouth city centre in October 1994 with "Multiplication," gave responses such as boredom, dread, fear, rote, difficult, pressure, embarrassment, intimidated, good, easy, useful. These were quite often supported by an equivocal response to "Mathematics."

Traditionally, multiplication tables have been associated with drudgery, boredom and frustration; for some it is an overwhelming experience. The BBC Numeracy Initiative found that for some the word "Mathematics" triggered off a range of emotions from stark fear to humiliation and despair. Unhappy memories of mathematics can be traced to people's early years when they were required to give rapid mental answers. Research has shown that children's total anxiety scores increased across the elementary school years; failure can lead to shame and humiliation.

Ginsburg [3] suggested that requiring rapid response to number fact problems may produce anxiety in some children. He suggests that many children display intense feelings of discomfort when they are placed in a typical fact testing situation.

He further suggests that children's experience will leave a lasting impression and may exclude any other, leading to children having a harmful attitude towards mathematics.

The Association of Performance Unit in 1980 suggested that it was the pattern of their responses to the four arithmetic operations that most clearly distinguished between those pupils who liked mathematics and those who disliked it [4], particularly of the 20% at the bottom of the 'liking mathematics' scale.

There was a sharp decline in their liking and a sharp rise in their disliking of arithmetic operation particularly multiplication and division.

What are the situations that might lead to negative attitudes? Possibly oral testing in front of their peers, being asked to respond instantaneously to problems rapidly fired at the class, having to stand up in front of the whole class to repeat a sequence of facts related to a particular table, or having to come out to say these same facts to the teacher whilst the class is carrying on with other work.

Children are often told to learn their tables without being instructed on the ways of committing facts to memory available to them.

When children are tested and fail to achieve the correct response they are asked to copy out the facts a number of times, or to stay in at playtime. These are perceived by the pupil as punishment and the teacher as helping them to commit these facts to memory.

References

[1] Ekinsmyth and Bynnes (1994), The Basic Skills of Young Adults, The Adult Literacy and Basic Skills Unit

[2] Sylva K (1994) School Influences on Children's Development, Journal of Child Psychology and Psychiatry vol. 35 no.1 pp135-170

[3] Ginsburg (1989) Children's Arithmetic: How They Learn It and How You Teach It. 2nd ed, Proed, Texas

[4] Assessment of Performance Unit (1980), mathematical Development, Primary Survey Report no.1, London, HMSO

Wendy Fortescue-Hubbard

School of Maths & Statistics

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Ten Commandments of Mathematics

1. **Thou shalt know thy times-tables by heart.**
2. **Thou shalt remember that zero times any number is zero.**
3. **Thou shalt not divide by zero.**
4. **Thou shalt not forget that minus times minus is plus.**
5. **Thou shalt not just add numerators and denominators when adding fractions.**
6. **Thou shalt remember that any number to the power zero is 1, and that factorial zero is 1.**
7. **Thou shalt not square when asked to find the square root, and vice versa.**
8. **Thou shalt not differentiate when asked to integrate, and vice versa. (Forgive me father, for I've changed my variables.)**
9. **Thou shalt never push the wrong button of thy calculator.**
10. **Thou shalt never forget that this should be the age of the brain.**

Dr. S. Roy Mid-Kent College of H & FE.

Maths Support on the Network

The e-mail maths-support group was set up after the 1995 conference at Luton University of the Maths Support Association. Anyone with e-mail can join.

We are a forum for all non-traditional forms of basic maths teaching and learning (and the accompanying resources) in FE and HE. In practice, we discuss issues to do with the effects of widening access, resources for learning maths, and innovations in maths teaching. All contributions are welcome.

There are over 100 members world-wide and we are growing.

To join, send this message:

Joinmaths-support <firstname><lastname>

to mailbase@mailbase.ac.uk

Deliberations: an interactive journal

Deliberations is an interactive journal of Teaching and Learning in HE. There are a series of pages on Maths - you can find articles of current interest, information on resources, links to other maths web sites, and a Debate section. The complete text of James Wisdom's article (highlights only on page 19) can be seen and printed. You are encourage to contribute.

The home page is: http://www.lgu.ac.uk/deliberations/home.html

Sybil Cock

Centre for Educational Studies

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Maths Support Association Membership Application

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Are you willing to join the editorial board for the next newsletter **YES / NO**

Are you willing to help plan the next conference **YES /NO**

I enclose a cheque for £15.00, made payable to "The University of Luton".
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In this issue