mathematics SUPPORT Newsletter

NATIONAL NEWSLETTER FOR ACADEMIC MATHS SUPPORT ISSUE 9 AUTUMN 1999

Listen, Think, Feel... teach Maths!

editorial

THE DYING words of a 'teacher of the old school' in R.F. Delderfield's book, *To Serve Them All My Days* were: "stupid boy".

This was poor feedback for the boy in question and definitely upsetting for the teacher. In this issue, we attempt to go beyond the platonic approach to learning maths and define a practical constructivist alternative.

David Bowers (Suffolk College) parodies the staff-room chat on the best line to take with the maths workshop and the depth of laughter of my colleagues tell me he touched raw nerves.

The 'old school' lives on; nevertheless, Mike Ollerton (UCSM) asks how a 'constructivist' teacher might be defined. John Searl (U of Edinburgh) offers the notion that such a person has the goal of developing a shared understanding between teacher and learners. He then wonders how we get there?

Forget textbooks or CAL as they reflect the expert's personal construals. In their place, he suggests practical experiences/ activities that create an environment for student to construct their own explanations of mathematical phenomena and discover it anew!

These are views shared by two American mathematics teachers at the U. of Minnesota. Scott Storla and Doug Robertson are working on fundamental requirement of a learning community for mathematics that can be generally applied.

They emphasise creating a shared language and creating one that is both a language of words and of mores. The inspiration to their thinking has been various attempts to create an environment where students can be effective teachers.

Pat Dannahy (Westminster College, Oxford) provides a review of a book that allowed her to teach her students a shared language in her classroom that addresses affective issues.

That touches an instant chord with me; isn't learning maths fundamentally about managing your feelings of frustration, when stuck, and also feeding your feelings of joy at finding resolutions to problems you think are worthwhile?

This issue has a second theme, namely to create a wider community of maths lecturers who wish to support their students learning.

The basic question is how do we cope, in practice, with the task we face. To keep us abreast of the direction and extent of our efforts, two recent surveys by Trevor Hawkes (Warwick U) and Ian Beveridge (Luton U) quantify those efforts.

Nicola Fleet (Croydon College) raises the quality issues in her article outlining what she wants from paper-based material. She raises the issues of the missing gaps in worksheet sets and also of the need to be able to edit the series locally. E.g. BODMAS, Basic Algebra skills, Directed Numbers etc.

Nicola highlights also the lack of practice examples in worksheets and texts. David Fisher describes a resource to meet this need in his article, at least for GCSE repeat candidates, created by several experienced teachers.

Paul Strickland (Liverpool John Moores University) explains the Tree-frog project as an attempt to help students learn algebra.

To that end it uses computer aided assessment techniques and also addresses the need identified by Nicola for teachers to edit published material without running into copyright trouble.

The Maths Support Association now has a web site! On it you can exchange opinions, download resources, and read back issues of our newsletter: see back page for details.

Special free resource

4-PAGE calculators worksheet!

PAGES 11–14

How (not!) to manage a Maths Workshop

The provision of Mathematics Workshops – also known as Maths Resource Centres, Support Centres and so on – has grown dramatically over the past ten years.

With the vast majority of HE and FE institutions now operating a workshop of some form or another, and with a number of these having been written about in detail in previous editions of this Newsletter, there seems little more that remains to be said.

Here, then, is a checklist of advice that you will certainly wish to ignore...

Don't waste time and resources publicising the existence of your Maths Workshop. If it has been running successfully for a few years, people will already know about it.

Students who need to attend for help and advice will probably find out about it by themselves. And the posters about the workshop you put up on noticeboards last year will probably still be there anyway.

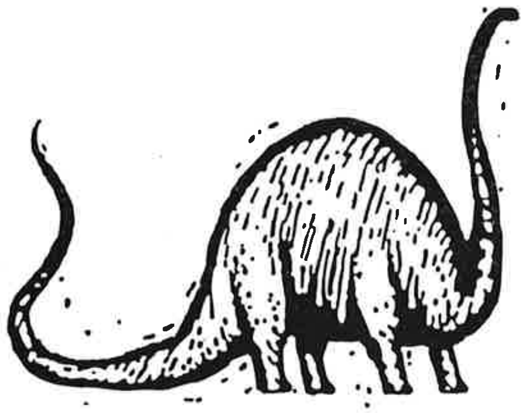
Run drop-in workshops at times most convenient to the staff. They are the ones who have to work there! It does not matter if there is no obvious timetable. The students who really need help will prioritise the workshop, however inconvenient the times.

And if a student gets the times confused, arranges a baby-sitter especially and drives in ten miles through a dark winter evening to find that no workshop is running, then she will know better next time.

A drop-in maths workshop does not need prioritising in terms of staffing. Get the proper classes covered first. Anyone with time left can do workshop duty; it does not need any particular skills. Better still; get in extra part-time staff to cover the workshop. Students with problems will be relieved to find that their regular lecturer is never around in workshop hours – how embarrassing that would be!

The resources in the maths workshop are valuable. Keep them securely locked away in cupboards. Only let students see them if they specifically ask. The resources won't last long if anyone can just walk in and use them.

Keep the door closed. Those in the workshop won't want to be disturbed by anyone outside. And the average student and lecturer outside finds maths bad enough as it is, without having to witness people in the workshop struggling at it.



There is no point keeping attendance records and monitoring student progress. If students do not want to attend when they are expected to, then that is their choice. You can lead horses to water, etc. If they have any anxieties or worries about being able to deal with the support provided, then that is their problem. They will probably fail their course. Nothing to do with us.

Maths lecturers tend to get annoyed when they hear that some of their students have attended the workshop for additional help. Do not let them know. Keep everything confidential. If a lecturer is told that students are having common difficulties with his course, then this could be construed as unprofessional criticism of his work. Avoid this at all costs.

When individual students attend a drop-in maths workshop for some extra help, they want to be reassured that the staff on duty are experts in their field. Demonstrate your mastery at every opportunity. Leave no aspect of the problem uncovered. Explain everything in full detail. The students will then have plenty to go away and think about.

Don't waste time giving the students some examples to try themselves, they will probably get them wrong again anyway and reinforce their belief in their own incompetence.

When a student group have a session timetabled in the workshop, treat it as an open tutorial. Ask them what problems they have. If nobody says anything, so much the better! Workshop sessions are not for learning new maths that is what proper lectures are for.

If it is the case that some student cohorts receive all their maths entitlement through workshop attendance, then somebody somewhere will have devised a scheme of work for them. Best not to get involved in that.

Make it totally clear on every occasion that the maths workshop's role is to give remedial support to students who are struggling in basic skills. Students attending the workshop should know that this is what they are buying into. Use the words "remedial", "struggling" and "basic" as often as possible. Then everyone will be in no doubt what those students are doing there.

David Bowers,
University College of Suffolk
Maths Workshop Manager.

The Ultimate Paper-based Maths Scheme

Take a large, light, and airy room; add a handful of friendly tutors, a few quality software packages and a generous helping of paper-based material. Mix together well and what have you got? A maths workshop which has not quite gelled...

Do you also feel frustrated with your paper-based maths resources? I have been running a successful maths workshop for some years now but am still not totally satisfied with the GCSE booklets we use.

As they were bought in at considerable cost it seems wasteful simply to trash them and start again. Thus I employ the 'make do and mend' philosophy; over the years the booklets have been supplemented and corrected.

Their content is 80% right; simple language is used, the text doesn't clutter up the page, illustrations are plentiful, the examples are varied, topics are introduced in easily digestible amounts and, best of all, we have the photocopying rights!

However a succession of changes to the GCSE syllabus has resulted in the in-house production of four new booklets and some alterations to the existing ones. This last necessity is frustrating, as the original booklets cannot be altered directly because of copyright laws. Consequently supplementary sheets are the only way to 'add-on' and this is not visually pleasing.

Even without the syllabus changes alterations were essential due to printing errors, missing topics (for instance BODMAS was completely absent) and to improve some poorly developed examples.

Fundamental lines

The latter may not seem so important but experience has taught me that well written text results in very good understanding and gives the tutor more time to work with weaker students.

If the same questions are consistently asked about a particular piece of text it is an indication that it needs careful scrutiny to determine whether fundamental lines are missing.

Another problem with the booklets is the lack of practice they offer (this is true of most textbooks as well). At the start of each exercise students need plenty of confidence building questions followed by an equally large quantity of more demanding ones.

When expansion of brackets is taught, the reader has eight questions of this type: $3x + 4(x + 3)$ before moving onto double brackets! Surely it would be more appropriate to start with this type: $4(x + 3)$?

At present the tutors can direct students to relevant back-up material, which consist of two types; Additional Notes explain topics further and Additional Practice Sheets contain supplementary exercises. These sheets were in existence before we opened our workshop and have been bundled together to match up with the booklets.

The above problems have given me the desire to write my own material based on the current booklets. As I stated earlier they are already 'almost right' but I am confident I could improve them substantially.

Unfortunately, however, I can't

MATHEMATICS SUPPORT
Published twice yearly

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The next issue will be:
Spring 2000

The deadline for contributions for inclusion in the next issue is March 31st, 2000

Discussion on Post-Constructivism

POST-CONSTRUCTIVISM

I gain access to 'Mathematics Support' via my HoD (Philip Gager) at UCSM and I was taken by the second paragraph of page 1, *"He (John Searl) challenges the assumption of constructivists that learners will attempt to make sense of mathematical problems"*.

I was therefore interested in trying to un-pack this statement, yet when I read John Searl's article, I could find no such challenge about constructivist approaches — have I missed something?

The statement does raise some important issues, such as how a 'constructivist' teacher might be defined. I personally don't think there is a recipe that anyone can work to, although I think that there are important principles about how teachers can help students construct their understanding of mathematics.

Whilst this is something I personally aim to achieve in my teaching, I also believe there are many other strategies, which might not fall under a constructivist description, but which I feel can be valuable.

For example, I learn my students' names by a process of constant repetition (saying out loud) and in this context I feel that such a learning strategy serves a valuable purpose.

My work, in the main, is with students who struggle with their mathematics and lack confidence. My task is to find ways of helping them build up, or construct, their understanding of concepts—concepts which proved relatively unimportant and often futile in the past. In this way, I would say that I am adopting a constructivist approach to teaching.

Mike Ollerton, UCLA

from page 3

use them because of copyright. It is also highly probable that they have already been improved by the original author(s) in which case I may still find fault with them!

To write a complete set of original GCSE material would:

(i) take time—I would guess six-months to a year full-time;

(ii) require a good imagination—to come up with problem-solving questions;

(iii) depend on resources—good computing packages and an endless supply of hot coffee.

Like-minded people

Sadly, things get in the way of good intentions: FEFC paperwork, internal and external meetings, marking, record keeping, phone calls, classes etc, etc!

Of course there is always the possibility of burning the midnight oil but I have a feeling that this may have the same effect as counting sheep. Besides, what if working alone simply results in another set of not-quite-perfect workbooks?

It seems to me that the most sensible approach is to work with a group of like-minded people and share ideas.

Whether this should be a set of mathematicians from one college, across a region or around the country is not very important; we have e-mail, faxes and phones so communication would not a problem. Working together and utilising individuals' talents should produce the 'ultimate' GCSE material.

My suggestions for a sound paper-based maths scheme would be as follows. It should be based on booklets, or sheets, with each concentrating on a discrete topic.

For instance Pythagoras' theorem and trig ratios could be introduced separately at first followed by a further booklet combining the topics through problem-solving examples and questions. All booklets should contain plenty of activities and graded exercises. A further set of back-up exercises would be helpful particularly if they reflect those in the booklets, thus providing extra practice.

At least two sets of assessment should be produced, to prevent the 'sharing' of solutions and for those students who do not reach a certain standard at their first attempt.

This 'topic-bank' approach would solve the problem of curriculum changes which I have found frustrating particularly when the addition of my own material appears to have a negative effect on a booklet's structure.

New material on disc

New material could be included with ease and at any point in any scheme; those of you who write customised programmes would surely welcome such a labour-saving device! I already use my existing material in this way.

Finally I suggest that this 'ultimate' maths scheme should be made available on disc, to be purchased at a realistic price. This would need to reflect not only the cost of production but also copyright, as I would be keen for each individual establishment to adapt the material as they wish.

Is anyone prepared for the challenge?

Nicola Fleet,
Croydon College

WHAT IS CONSTRUCTIVISM IN THE MATHS CLASSROOM?

I guess my understanding of constructivism to be as outlined in the NCTM Monograph on Constructivism, and augmented by reading 'Woman, fire and dangerous things' (Lakoff). Your paragraph suggests that there are such things as zero, as basic operations etc., whereas I would say that these are not 'real'.

I would want different questions addressed on the basis of facilitating my classrooms on radical constructivist lines. There seems to me to be a contradiction between the subjects of your questions, constructivism and post-formalist thinking.

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(Patricia Dannahy)

THERAPY MORE EFFECTIVE THAN REMEDIATION

It was interesting that Ian Beveridge read between the lines of 'Therapy more effective than Remediation' to find a challenge to the unmoderated assertions of constructivism. It is a theme I have touched on before in a gentle way (see, for example, *'Mathematics, technology and mathematics teaching'* in MT 162).

Of course the nice thing about the platonist-constructivist debate is that it is ultimately unresolvable but that the debate itself heightens awareness of the nature of the teaching-process.

At the tertiary level much of our service course teaching (and certainly our assessment) implicitly adopts a platonist view. We observe teachers who perceive mathematics as a body of knowledge to be covered and students who think they would learn mathematics more easily if only it were better packaged. There are facts to be learned and skills to be acquired. Our less able students certainly perceive mathematics that way.

Those students are more usually concerned with trying to reduce mathematics to a manageable set of rules which will enable them to pass the examination. Understanding for them is identifying which trick to apply and how to apply it. They struggle not so much with understanding the mathematics (they gave that struggle up many examinations ago) as with rote learning a technique which will produce the required outcome.

It is not difficult to adopt a view which says that 'green' does not exist/ has no meaning apart from green grass. It is more difficult to adopt a view which says that mathematics has no existence or meaning apart from its application.

The teasing thing is that while that assertion may be true, we have the impression when we are working in mathematics that we are discovering rather than inventing mathematics. But of course mathematics is an invention of the human mind, created for the triple purpose of:

- Describing reality for one's self or for others
- Solving problems for one's self or for others
- Testing assertions for one's self or for others.

It is the 'for others' aspect of these purposes that causes us to teach in a platonist manner. There is plenty of experimental evidence that people create mathematics for their own use. (See, for example, van den Brink, *'Occupational Mathematics'*, MT143.)

The social need, however, demands a shared and sharable mathematics so that instead of constructing their own mathematics students are required to learn mathematics developed by another and to show the creativeness and inclinations of that other and not of themselves.

Of course it is possible to short-cut the knowledge construction experience. For example it is possible to understand elementary calculus without the knowledge of Euclidean geometry on which its development rested. The resulting understanding will be different from that of Leibniz, Newton and their contemporaries.

Their dynamic geometric approach may make the use of calculus in mathematical modelling more accessible to students but it makes the logical understanding of the rules of calculus obscure. Using modern notation it is possible to develop the subject quickly but something is lost.

And so many students will be puzzled by the definition:

f'(a) = lim ((((

having been told earlier that 0 (0 has no meaning. They will shrug their shoulders, abandon it as one of those little mysteries of mathematics they will never understand and move on to rote learn the rules of differentiation required for their assessments. I am reminded of the Peanuts cartoon:

Linus asks Lucy "How much is six from four?"

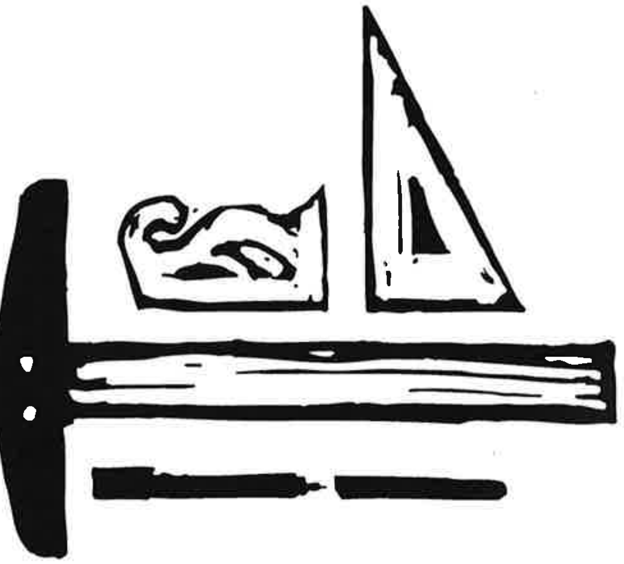
Lucy replies "You can't subtract six from four. You can't subtract a bigger number from a smaller number."

To which Linus replies indignantly "YOU CAN IF YOU ARE STUPID!"

The situation is made complicated, as pointed out by Eddie Gray and David Tall ('Success and Failure in Mathematics', MT142), by the mixture of concept and process in much of mathematics, so that the process of 'take away one' is easier to apprehend than the concept of 'negative one'. And the use of the same symbols for both may aggravate the difficulty for the would-be learner. The fact that the process is often (but not always) easier to apprehend and to assess explains the focus, in much remedial work, on instrumental learning.

As I have illustrated above, mathematics is often presented in a formal way, by-passing the development of the underlying concepts and leaving a logical, 'tidied up' version, based on somebody else's abstractions.

When a topic is presented in this way, the learner has no means of tackling conceptual difficulties if they arise. The mathematics becomes too formal and too abstract too quickly for many learners and while they may be able to perform the assessment tasks required of them, they may have an inadequate understanding of the underlying concepts. Of course being able to perform the tasks is a desirable outcome!



Developing understanding in learners depends on developing a shared understanding between teacher and learners. To develop that shared understanding depends on a valid appeal by the teacher to the learners' intellectual experience.

The difficulty faced by the teacher lies in making that valid appeal, in knowing "where they are". This may be aggravated by the mathematical inarticulacy of the learners or by their inability to identify what they have not apprehended.

The traditional textbook and many computer assisted learning packages tend to be structured in accord with the intellectual experiences of the authors and their construal of those experiences. Consequently they may make a valid appeal to the experience of only a few in their audience. The appeal may be too narrow or wrongly focused to be successful with many of the would-be learners. This suggests that a broader and more diffuse appeal has to be made and one that is less dependent on the mathematical constructions of the teacher or authors.

In some sense the teacher needs to experience the stimuli that will generate anew in the teacher the understanding desired in the learners. (This is not a new observation. In 1886 Chrystal wrote in the preface to his innovatory textbook 'Algebra' that the very large number of exercises had been given for the benefit of the teacher that he (sic) might have, year by year, in using the book a sufficient variety to prevent mere rote-work.)

Clearly it is not possible genuinely to recreate the learning process for the teacher but it is possible to create in the classroom an environment in which the teacher and learner work side-by-side and develop common experiences enabling the process of making a valid appeal.

This implies that the formal approaches afforded by textbooks and CAL need to be complemented by informal approaches that are more flexible and open. Investigative work and practical activities provide such approaches.

Many authors have discussed the role of investigative work. In contrast while the importance of practical work in the primary mathematics classroom has long been recognised, their role in post-primary education has not. This may be because the underlying pedagogical/psychological theory is not well understood.

Simple practical work can provide a shared experience for teacher and taught so that there is a common beginning position from which shared understanding may grow. (See Fiona Grant and John Searl, 'Practical activities in the mathematics classroom', MiS 26,4.)

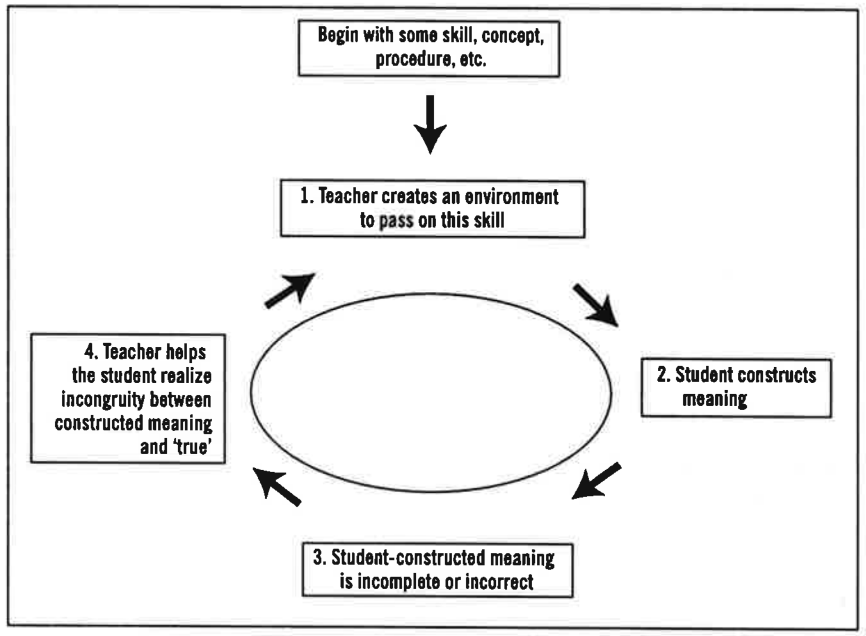
Thus shared knowledge acquires the appearance for the learner as a body of knowledge independent of those who have acquired it and to the teacher as body of knowledge independent of those who need to acquire it!

John Searl,
University of Edinburgh.

Establishing a Learning Community for Mathematics

We began this project at the University of Minnesota, General College, in the autumn of 1986.

Originally we were attempting to incorporate a constructivist philosophy into developmental mathematics courses. In a general sense a constructivist class could be thought of as following the outline on the right.



The difficulty with implementing this model is the teacher is responsible for step 4. Since a teacher can't complete step 4 with every student our idea was to help the students become better teachers.

Helping students become better teachers requires they teach something of value and that the classroom atmosphere support humane student interaction.

As we developed individual pieces to address these issues we realized that in essence we were developing a community for learning. So far we have become comfortable with five of the six identified components of the community.

We will discuss the five we are comfortable with first and leave the sixth for discussion at the end.

The Components of a Learning Community

To be effective a community needs at least these five components.

1. Share a common vocabulary
2. Share common norms of behavior
3. Appreciate both shared and individual histories.
4. An elder.
5. Build for posterity

Let's look at each of these separately:

1. Share a common vocabulary

Students need an effective mathematics vocabulary to understand the instructor, understand each other, understand the textbook and most importantly to construct personal meaning when they talk with themselves.

We found that the meaning students had assigned to common mathematical terms, (such as factor, term, sum and product), were often ambiguous or wrong. We decided to make vocabulary an essential part of the curriculum. Here are some ways we incorporate vocabulary into the curriculum.

a) Have students build vocabulary note cards.

b) Introduce interesting questions that are vocabulary based.

Use the words sum, term, factor and product (you may need to use more than one) to completely describe the following expressions:

In the expression $x(x + 1) + 2(x+1)$:

$(x + 1)$ is a ____________

2 is a ____________

$2(x+1)$ is a ____________

$x(x + 1) + 2(x+1)$ is a ______

c) Make vocabulary an important part of tests.

We have found some interesting results from emphasizing vocabulary. For example, a common student complaint such as, "I can follow you in class but when I get home I get all confused", may have its roots in the lack of an effective mathematics vocabulary.

When students get home they need to be able to cue themselves regarding what they should do and when they should do it. Without an effective vocabulary these necessary self-discussions don't happen.

2. Share a common norm of behavior

Common norms help students predict the behaviors of others. This allows many students to feel more comfortable in class. It's important to consider both in-class and out of class behaviors. Solver-questioner pairs (Problem Solving & Comprehension by Whiimbey & Lochhead, LEA) are an example of an in-class behavior.

If the lesson for today is learning exponent rules (laws of indices) one student could simplify the expression while the other student was responsible for making sure the solver could justify each step by specifying the appropriate property or definition.

This builds the norm of justifying each step in a mathematical process. It also reinforces mathematical vocabulary since words such as factor, numerator and denominator naturally become part of the discussion.

Homework would be an example of an out of class behavior. One instructor may expect students to turn in homework every day under the assumption this reinforces the behavior of timely and appropriately paced mathematics work.

Another instructor may not expect students to turn in homework using the assumption that it's important for college students to develop the norm of work for it's own sake.

In both cases the instructor has decided on an appropriate norm of behavior which is now part of this particular classroom.

3. Appreciate both shared and individual histories.

Although it's important to let students know about the history of mathematics and mathematicians this topic is concerned with history in the way it affects your individual classroom.

An example of shared history would be constant review of questions a majority of students missed on a test. Another example would be to include a test question based on a spontaneous in-class discussion concerning some part of the curriculum. (Notice this also reinforces the norm of behavior of class attendance.)

An example of individual history would be how you react to differences in the knowledge-base students hold when they first enter your class.

For example; if a student has a knowledge-base which is substantially smaller than others in the class, is the appropriate response ostracism (allow them to sit in the back of the class), alienation (show impatience after the fourth unnecessary question), remediation (set groups so others can help them join the community), banishment (move them to a lower class)? These are issues for which the context of a community can help us view old concerns in a new light.

4. Instructor as elder

There have been many nouns used to describe the instructor. During our years we have seen mentor, coach, facilitator, guide etc. For the purposes of a community we believe 'elder' is the best choice.

The role of the elder is to pass on the vocabulary, norms of behavior, and history of the community. Elders do this through their own behavior. For example, if punctual attendance is important to you, then it's important you arrive to class on time. If you want students to be able to describe their thought processes then it's important you teach class by describing your thought processes.

An example of this would be, "I first notice this is an expression so I know I will not be solving for x. Since the directions say to simplify I know I will need to perform all of the operations I can. Using the order (sequence) of operations I first look for grouping symbols." Etc.

A second way elders influence the community is through sharing of their own personal experiences. All of us have been successful at something that we call "college". Our students also want to be successful in college. It's important that you share with students your own personal history. What helped you succeed in college? When you fell short what did you learn from the experience?

Sometimes what you pass on is academic in nature, such as a study technique. Sometimes what you pass on is affective in nature, such as college being a marathon, not a sprint. It's important students realize that even though your classroom is a community they have also entered a larger community, the community of college educated people.

5. Building for posterity

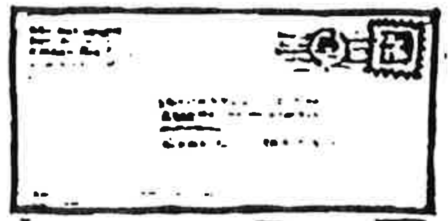
When students enter your class it's important they realize they are not just there to pass exams but to build both the relationships and understanding needed to be part of a learning community.

It helps to Inform students directly of this and quickly open up the class to wider issues than technique, expecting students to engage in issues of process and also in determining the environment.

We mentioned at the beginning there was still one issue we have not resolved. This is the issue of goals. Just like in a real community different members have different goals and the issue is neither trivial nor easy. Your ideas are welcome; please email us at:

Scott Storla and Doug Robertson
University of Minnesota.

Letters



Interactive Past Papers

In the last edition of the *Mathematics Support* journal Ms Chetna Patel gave a very good review of Interactive PastPapers for Higher/A Level Mathematics. There were a small but significant number of inaccuracies and misconceptions and with the reviewer's and editor's permission I am writing to clarify some issues.

First of all the authors of Interactive PastPapers are C E Beevers, D J Fiddes, G R McGuire, D G Wild and M A Youngson and not the much longer list of authors stated in that review. The RRP or recommended retail price is £29.99 and not £39.99 as stated.

The review seemed to imply that the sound facility was central to the program but it is merely a small feature for those with the appropriate sound card and merely serves to help the first time user get started. The assessment program itself does not rely on sound in any way.

There are substantial differences between the Higher and A Level versions with more than twice the number of questions in the A Level banks. In fact, there are in excess of five questions per topic bank in each of fifteen banks and not just three as quoted in the review.

Moreover, and most importantly, each question has random parameters so that each time the user takes a question the numbers change and hence a user does get plenty of practice with each question type.

It is difficult to imagine a crisp exam on a computer when so many of our own experiences recall the thrill of opening up a paper exam! But, the times are changing and our own students at Heriot-Watt University in Edinburgh have had plenty of practice at using the computer to assess their mathematical skills. They seem to derive the same thrill (or is it fear?) that grips all of us when we are under scrutiny. Interactive Past Papers does provide the same thrill albeit electronic.

Finally, the saving of files can be slow but that is dependent on how well the Windows setup has been established on the user's PC.

Let me end by pointing out that the authors of Interactive Past Papers have just created a GCSE/Scottish Standard Grade Mathematics product and this is also now available for a rrp of £14.99. The new product contains over 120 different question types in the 25 topic areas: Compound Interest, Percentages, Scientific Notation, Speed Distance and Time, Similar shapes and ratios, Circles, Volume, Area, Pythagoras, Brackets and equations, Quadratic Factorisation, Index Notation, Sine and Cosine rules, Inequalities, Proportion and variation, Trig equations, Straight line, Simultaneous equations, Formulae, Functions, Simplifying surds, Tables, Factorisation, Finding roots, Miscellaneous.

Again random parameters are a feature and so there is unlimited practice for students at this level. This product is being marketed by Lander Educational Software of Glasgow and more details can be obtained by calling freephone 0800 403040.

We have also created some learning units at the level of pre-university Mathematics covering the following topics: Analytic Geometry of the Line, Analytic Geometry of the Circle, Basic Algebra, Differentiation, Trigonometry and Probability. These units of CAL courseware cover theory, worked examples, self-assessment questions and each of the ten units has a more formal test section.

More details on (and favourable prices for) these products can be obtained by contacting me in the Department of Mathematics, Heriot-Watt University, Riccarton, Edinburgh, EH14 4AS, telephone 0131 451 3233 or by email on c.e.beevers@hw.ac.uk.

Prof Cliff Beevers

Grade our Links! Feedback wanted for our Web site

We would like to make the CTI Mathematics Web pages as useful as possible to mathematics lecturers, and would appreciate comments from you or other members of your department about the pages listed at the end of this message.

We would also like to improve the gateway by adding links to useful sites for teaching and learning mathematics. Any favourites of your own or your colleagues are welcome, but we would particularly like to have a link to the teaching and learning pages of your own department, especially if there is any account of the use of computer-based resources.

Comments about the CTI Mathematics Web site would be welcome especially about the following pages:

The home page:
www.bham.ac.uk/ctimath

The gateway (links to other sites):
www.bham.ac.uk/ctimath/gateway

The newsletter:
www.bham.ac.uk/ctimath/newsletter

The diary:
www.bham.ac.uk/ctimath/general/g-diary.html

The search facility:
www.bham.ac.uk/ctimath/excite.html

Send reply to:
p.bishop@bham.ac.uk

What is it like as a student in your class?

Qualities that I would look for in a teacher are:

- good listener
- flexibility
- understanding
- good presentation
- punctuality

a good teacher should:

- listen as well as talk
- be willing to adapt to suit the needs of the student
- have more than a superficial appreciation of issues (subject, people...)
- be clear and concise
- be available for consultation

Nicolas Greensmith
Research Student
School of Computing and Mathematics
The University of Huddersfield

DeLiberations

(on Teaching and Learning in Higher Education) is an interactive electronic forum that covers a range of disciplines and educational issues. You can find us at:

www.lgu.ac.uk/deliberations/

Do Students Need Algebra Skills or just familiarity with the notions?

Perhaps the problem with many teachers in Science and Engineering is in failing to recognise that it is not necessary to develop full professional standard in the skills before they can be applied in a meaningful manner.

Geoff Walker
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University of Teesside
Middlesbrough TS1 3BA
email: g.f.walker@tees.ac.uk

Using the web as a resource

In December 1996 I asked for information re teaching materials on the Web and Institutional startegies for producing web documents. Here is a summary: altogether I recieved 96 replies, 24 from overseas and the rest from academic institutions in the UK.

Unfortunately, being new to this area, I made the classic mistake of assuming that people would understand my project description of teaching materials on the web, therefore I received a lot of information that was not directly relevant to this project.

David Hawkridge, The Open University, outlined the various uses that their Institution made of the web and I agreed with him that it is the final category into which our project would fall :

1. as a resource for students and tutors seeking pages of value to their studies
2. as a means of passing students' assignments between students and tutors
3. as a system for accumulating in an 'electronic workbook', open to students and tutors, our students' responses to questions posed throughout the print materials, and tutors' comments in these responses
4. as a conferencing system
5. as an emailing system
6. as a means of accessing 'private' pages of specially-prepared course material.

Only 39 of the responses I received actually described usage of the internet in this way. The remainder described courses, tutorials, information gateways, etc. that they have established—which are not presently relevant to us, but will certainly be in the future.

All of the responses described an individualistic 'grass roots' approach to putting teaching materials on the web, i.e. any developments were dependent on the work of enthusistatic individuals.

Only one institution said they had an institutional strategy for producing web pages, with only 8 institutions discussing the possibility of formulating one. Despite this most respondents reported a keen interest in this area, and felt that this was definitely a swiftly developing issue in their Institution.

The majority of overseas responses came from the USA. They also gave the impression that use of the web as a resource was being carried out on an individual level, with no mention of an institutional strategy/approach. The difference from the UK seemed to be that a greater number of individuals were doing this than here.

Many respondents supplied URLs of their work and below is the only Maths one:

Dr. T. O. Hawkes,
University of Warwick.
www.maths.warwick.ac.uk/maths/undergrad/ma

Mathematical Modelling

I wish to compile a list of suitable starting points for mathematical modelling. Ideally these would be accessible to a wide range of mathematical treatments so as to make them useful to a wide range of mathematical ability, from say Secondary level to H.E. If you are interested in helping to produce this list, send me your ideas and your email address and I will return a composite list of ideas from all respondents to all respondents.

Thanks!

D.N.Smith@shu.ac.uk

Calculators

Introduction

There is no doubt that we need basic numeracy skills so we can make reasonable estimates. Such skills help us when shopping, buying expensive goods on credit, arranging mortgages and insurance. These include some of the biggest decisions of our lives which have to be made quickly or we end up having to accept the word of someone who wishes to make up our mind for us.

Here we have the objective of improving basic numeracy skills of estimation. If you put in hours fiddling with numbers, the end result will be a better sense of what is appropriate.

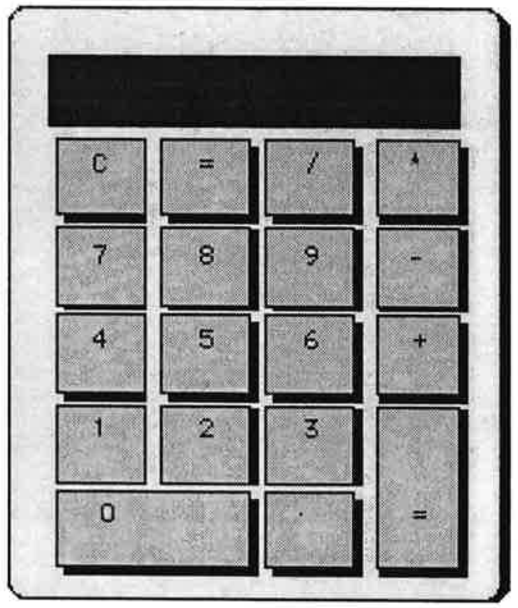
You use a calculator when it makes sense to do so and the extent of your use is up to you. At the end of your efforts with this worksheet, we hope you find new uses for your calculator. We think it makes sense to use the calculator where:

- arithmetic must be done quickly and partial results need to be remembered.
- arithmetic is complicated
- we use realistic data
- confidence is useful
- attention is to be focussed on strategy
- it can be used as a teaching aid
- we can look at problem-solving techniques

The keyboard

If you have bought a scientific calculator (Casio FX82/83/85 or 115 are recommended) you will find several keys besides the ones you see on the simple calculator to the right. It shows the keys of a computer calculator where C=clear screen, / means divide, and star * means multiply.

See if you can find the following keys and then check with the persons sitting around you:



- ❑ **AC** all clear key (this one clears the screen and the memory)
- ❑ √ square root key (find the square roots of 16 and 9 and 8)
- ❑ π Find pi (the distance around any circle divided by the distance across it)
- ❑ [(Find the brackets (these let you change the order of operations
- ❑ $a^b/_c$ Find the fraction button
- ❑ $^1/_x$ Find the reciprocal key
- ❑ x^2 Find the square key
- ❑ x^y Find the power key
- ❑ $x^{1/y}$ Find the root key
- ❑ +/– Find the change sign key

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Practising your Calculator skills

Order of Operations

$6 - 3 + 7 - 9 + 4 + 2 - 5$

$12 \times 3 \div 6 \times 5$

$4 \times 14 \div 3 \times 27$

$(12 \div 14) \div (25 - 6 \times 2)$

$[(20 \div 7) \div 3 + 15] \times [(11 + 3) \div 2]$

$(4 + 3)^2 \times 5^2$

Negative Signs using [+/–] key

5 [+/–] + 4 =

7 × 5 [+/–] =

2 × 9 [+/–] × 3 [+/–] =

$2 - {}^{-}6 =$

$^{-}7 - {}^{-}9 =$

Square Roots using √ key

$\sqrt{16}$

$\sqrt{49}$

$\sqrt{30}$

$\sqrt{8.59}$

$\sqrt{1024}$

Using Percent % key

20% of 250
type: 250 × 20 shift %

17.5% of £840

57 is what percent of 76?
type: 57 ÷ 76 shift %

What percent of 36 is 9?

What is £85 after VAT of 17.5% is added?
type: 85 × 17.5 shift % +

What is £85 after a 10% discount?

Using Konstant Feature by pressing operation key twice

Constant addition: Add 25 to {5,101,15.28}

25++ then 5=, 101=, 15.28=

Take 2.5 from list of numbers {5,101,15.28}

2.5– – then 5=, 101=, 15.28=

Constant multiplication: 1.1 × {5,101,15.28}

1.1×× then 5=, 101=, 15.28=

Divide a list of numbers {5,101,15.28} by 7

Using Memory keys M+ M– MR

Example: 8x7 + 7x4 – 5x2.3
first clear memory by pressing **AC** and **Min**
then type in 8x7 **M+**, 7x4 **M+**, 5x2.3 **M–**
Now press **MR** (recalls contents of Memory)

3x11 + 7x8

$4 \times 14 + 3 \times 27$

5x13 – 17÷4 – 6x17

[(20+7) ÷ 3 + 15] + [(11+3) ÷ 2]

$(4+3)^2 - 5^2 - 1.73 \times 9.3$

Nim

Acquire a partner and a calculator and play this ancient Chinese game.

Play it several times.

Try and work out how you can always win the game.

Rules:

- Enter 21 into the calculator
- Subtract 1, 2, or 3 each turn
- Alternative turns with your partner
- the player who brings the total down to nought is the winner.

After playing a few times, answer these questions:

When the display is 4, how do you know you can win on the next go?

If the display is 8, how can you guarantee it will be 4 on your next go?

If 4 and 8 are "critical" numbers, what is the previous "critical" number before the 8?

What is the critical number you want to reach before 12?

List the critical numbers in order, beginning with 4.

How did you find them?

If you are the first player to go, how can you guarantee to win?

Suppose you begin from a different number than 21, say 50, and the numbers to be subtracted are 1, 2, 3, 4, or 5. What strategy might you then use to force a win?

Invent a similar game together with a winning strategy for it.

No Limits

What is the biggest number you can think of that uses just 4 single digits?

Palindromes

12534
+ 43521
= 56055
+ 55065
= 111120
+ 021111
= 132231

A Number Palindrome is a number that reads the same both forward and backwards, such as 7227.

You make one from any number:

- reverse its digits and add to get 56055
- reverse the digits of the sum (55065) and add
- reverse the digits of the new sum (111120) and add again.

It took 3 additions to make a palindrome (132231).

Can you find a number which needs more additions?

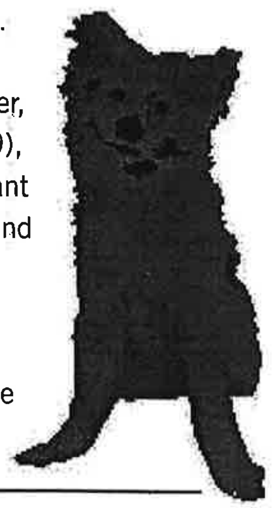
Cats & Dogs

Example:
Person 1 enters 13÷÷
then = (to hide No.)
Person 2 enters:

guess	result
100 =	7.692
30 =	2.307
10 =	0.769
15 =	1.153

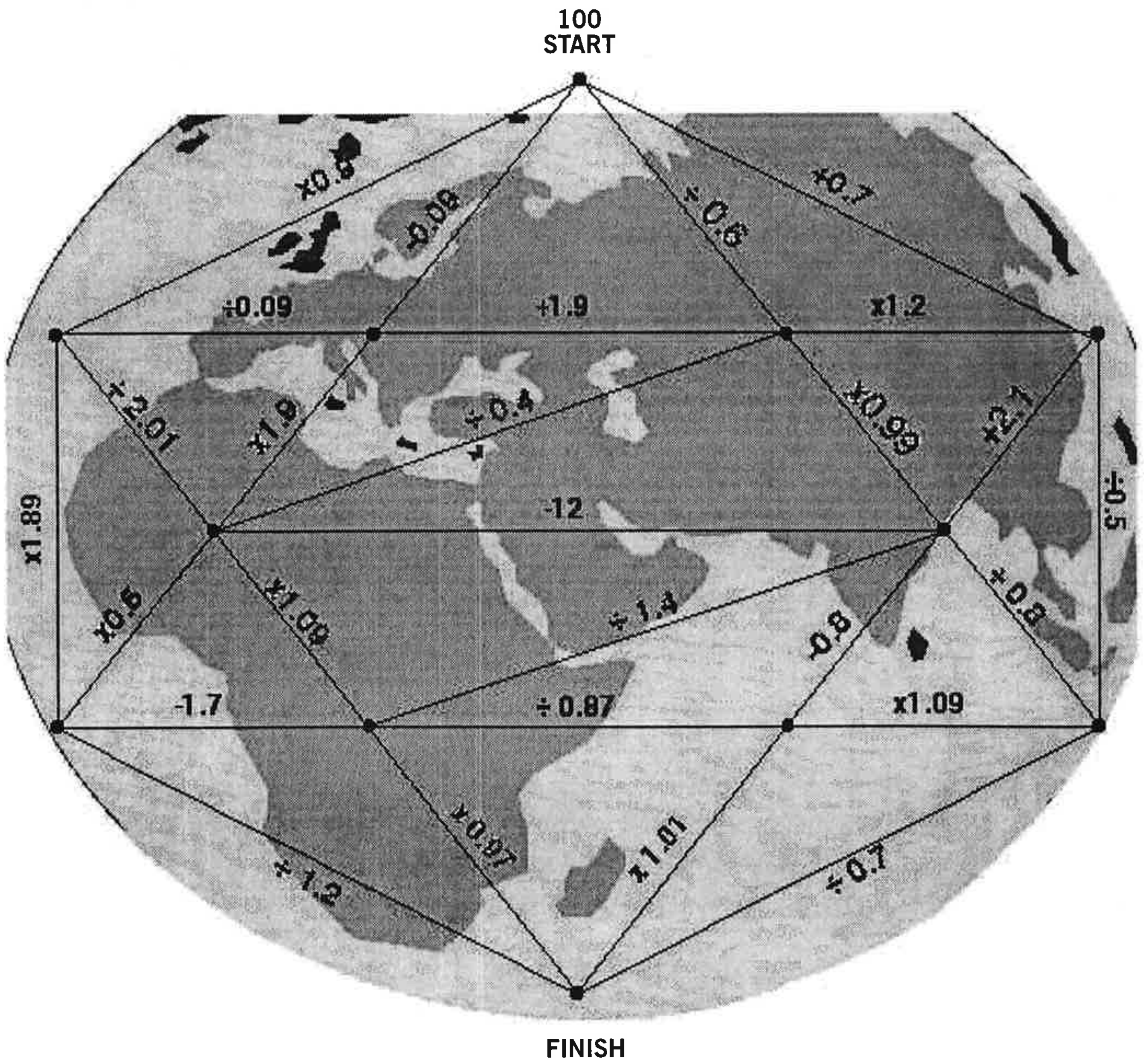
final guess is 13 or 14

Pair up and share one calculator between you. This is an activity where you swop roles with each play. One person secretly enters a number, say 16 (any whole number between 2 and 99), by pressing 16÷÷ (and make sure the constant K is on the screen). The other person has to find the number by making up to 4 guesses (only whole numbers allowed), entering it and pressing the equals sign. She/he uses the answer to inform a better guess. Record all the guesses as in the example.



Around the World

Starting with £100, how much can you make as you ***go South*** around the world?



Review

Rosenberg R (1999) NonViolent Communication, California, USA: PuddleDancer Press

Both my experience and my research tell me that something different happens in my classrooms when I marry the teaching of mathematics with encouraging students to express their feelings and needs.

The incidence of 'turning on' students to maths, students who had earlier told me that they 'hated maths', goes up.

If in addition I choose maths content which has meaning for me or the students—what I call 'live mathematics'—then this too makes a positive difference. I have come to believe that students learn mathematics when to do so meets one or more of their needs.

BREAKTHROUGH

It has taken me a long time to find a way to integrate the expression of feelings and needs into my mathematics teaching.

The breakthrough came three years ago when I found out about Marshall Rosenberg's "NonViolent Communication" (NVC) and took part in training courses to learn how to express myself nonviolently. Rosenberg has just brought out a new book called simply "NonViolent Communication".

This is a 'how to' book.

The premises from which Marshall Rosenberg starts are that compassion is a basic human state and that the specific process we use in communicating can make all the difference to how our message is received.

NVC is an approach that can be effectively applied at all levels of communication and in diverse situations from self-talk to international politics. He includes examples from education in particular.

Rosenberg states that there is nothing new in the NVC process; that it is to remind us about what we already know about relating to each other and to show us how to live in a way that concretely manifests this knowledge.

EVALUATION

The NVC model for communications includes: observing, without judgement, actions that effect our well-being, stating our feelings as we observe the action, saying what needs, values, desires are connected to the feelings, and requesting the concrete present-time actions we would like.

For most of us it is difficult to make observations of people and their actions which are free of judgement, criticism or analysis. When we include evaluation in our observations people seem to be more likely to hear us as criticising them. Rosenberg advises that we strive to separate observation and evaluation.

For the second component of the model many people need to learn a more extensive feeling vocabulary and allow themselves to be vulnerable enough to express their feelings: this expression enhances connections between people.

COMPASSIONATELY

Next we need to learn about our own needs. We are good at thinking about what is wrong with others. So, for example, if we ask for maths work to be given in at a particular time, and a student does not respond as we wish, we may describe him/her as lazy or disorganised.

The fourth component of the model is learning how to express what we would like in a way in which others are more likely to respond compassionately.

We also need to learn how to find out if our message has been adequately heard.

Rosenberg's model is used both for expressing ourselves honestly and receiving empathetically from others. At the beginning of any interaction we always have the choice of receiving information or expressing our own.

If I'm angry with you I have the choice of telling you about it or listening to your experience of the situation. In receiving empathetically we still use the model and listen for the other persons' observations, feelings, needs, and requests.

ENJOYABLE

Rosenberg includes many songs, poems, stories, anecdotes and exercises in his work in order to illustrate his points. This makes his book enjoyable to read as well as a valuable communications course.

Using NonViolent Communication has changed the quality of my interactions with students, with my family and friends, and with my colleagues.

I recommend it to you.

Pat Dannahy is Authorised as a trainer of NonViolent Communication (NVC) by the Centre for NonViolent Communication (CNVC): she lectures in mathematics to intending primary teachers at Westminster College, Oxford

You can obtain this book in the UK from Pat @£12.99, £14.99 including postage and packing

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p.dannahy@ox-west.ac.uk
CNVC website:www.cnvc.org~

TREEFROG: Computer-Aided Assessment in Algebra

AIMS OF THE PROJECT

Our initial aim in starting the TREEFROG project was to help students learn algebra. As is well known, the keys to success in algebra are good teaching coupled with plenty of practice. In order to be effective, the learner must receive plenty of feedback, so that correct work leads to positive feedback and incorrect work does not.

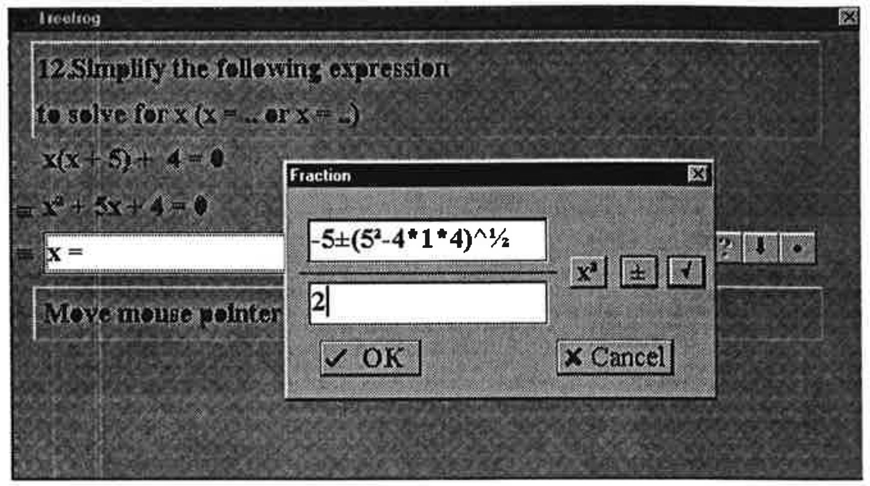
Many projects exist to develop software which supports the teaching of mathematics, such as the MATHWISE packages, TRANSMATH, in HE and FE. Moreover, there are innumerable offerings aimed at getting pupils through GCSE.

On the "drill and practice" side, the CALM project introduces the idea of evaluating real- and complex-valued functions at randomly selected values of the domain variables in order to check students' responses. Also, this technique has also been successfully employed within the CALMAT system and the DIAGNOSYS assessment package.

We feel that there is potential to extend this functionality to other areas of algebra, not directly susceptible to the random evaluation technique, and hence the birth of TREEFROG.

By applying standard mathematical rules to a pair of equivalent expressions (such as "expand brackets", or "move all the terms to the left-hand side of the equation") we can hope to reduce them to the "same" form which we call a normal form.

It usually necessary to allow some latitude in what we mean by "same"; for example the case of operands of commutative operators being presented in different order, a*b = b*a. We may also need to perform an initial transformation to each side, as in comparing integrals by differentiation.



We also feel that the software will be most useful if the interface mirrors the use of pencil-and-paper as closely as possible. We intend to build in John Appleby's input tool, used with the DIAGNOSYS package, at a future date; for now we have included dialogue boxes for the more natural input of fractions and square roots, as are needed in the solution of quadratic equations (see screenshot above).

Another aim of the project is to give the lecturer, or teacher, as much control as possible over the content of the practice material.

This should include the ability to alter the wording of questions and the on-line advice such that it reflects their own teaching style. There might also be some flexibility in setting the definition of what they would regard as a satisfactory finishing point for an argument.

Software to record student results is in the development stage. This will enable lecturers to identify both students having problems as well as identify general areas of weakness (of all students). In the longer term we hope to build in intelligent feedback as to why errors are being made, but this is still work in progress.

PROBLEMS

We are satisfied that the use of rewrite rules has opened up most areas of basic algebra to be supported in this fashion. In addition, within our shell, more areas can be added relatively easily.

We are in a continual process of gathering feedback on the system, allowing us to make improvements in the interface for the student. Educational research confirms the value of learning manipulative skills in algebra.

A major difficulty is a lack of teachers' and lecturer's time to prepare questions. It may be that the provision of an extensive library of question sets via the world-wide web will be the most satisfactory method of giving control to the practitioners, together with a WYSIWYG editor to edit them.

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Computer-aided assessment page
java.cms.livjm.ac.uk/treefrog/treefrog.htm

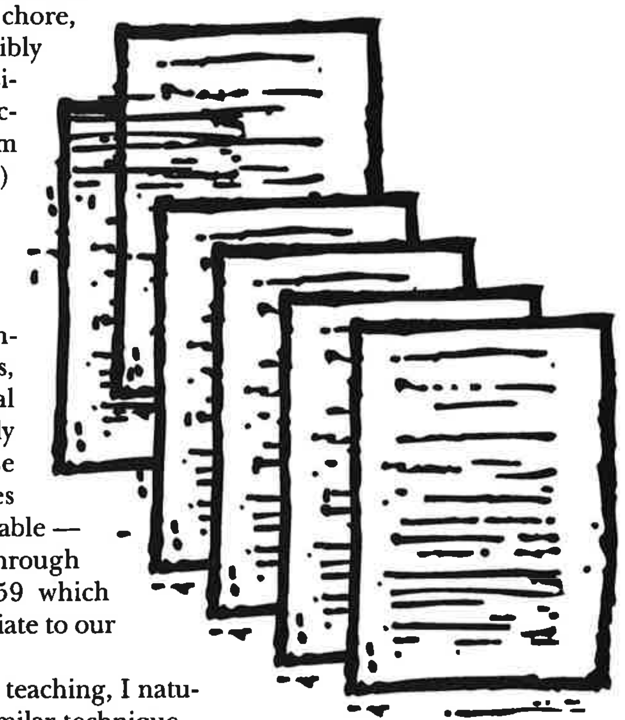
Papers ! Papers ! Papers!

You've taught the course, you've set the exercises, you've marked the routine work. Your students are (you hope!) reasonably competent at each individual topic on the syllabus.

But exams aren't like that, and for each student to get the best grade of which he or she is capable requires practice on papers as similar as possible to those they will face in the real exam.

When I was at school in the 1970s we did a timed test and a past paper every week for a year leading up to O-level, and much the same system applied at A-level so far as time allowed.

Far from making Maths a tedious chore, this system (sensibly applied, with sensitive and constructive feedback from the teacher) proved invaluable for building confidence and familiarity with the style and content of the exams, so that the actual paper was simply Test 26! In those days syllabuses remained fairly stable — we worked through papers from 1959 which were still appropriate to our course.



When I started teaching, I naturally adopted a similar technique – after all, the people who really taught me to teach were my teachers at school. However, in the rapidly changing climate of the 1980s and 1990s it became impossible to use the same set of papers for long. Topics went in and out of the curriculum at an alarming rate.

In 1993, with the National Curriculum about to feed through to GCSE, I decided not to try to adapt old papers to the new syllabus but to set 25 totally original tests for use with my students.

Having recently acquired some computing power I was able to produce a reasonably professional-looking set of test papers, complete with diagrams, answers and mark schemes, and wondered whether other teachers would find them useful. A mail-shot to secondary schools brought astounding results: 500 customers in the first month! That was the beginning of DELPHIS Publications.

In due course further sets were added for the different tiers of GCSE, (followed by A-level materials. We now have a team of five writers compiling papers from Key Stage 2 up to A-level Further Maths.

We have learnt along the way — especially about the need for great care to prevent errors from slipping through — but have generally had very positive comments from customers. Some use the papers as timed tests, others as homework assignments to supplement actual past papers. All our materials are sold as photocopy masters and are kept to as few sheets of paper as possible, for ease of duplicating.

Our current publications include the following. Prices include postage, packing, and full copying rights for the purchasing establishment. We deal only with schools and colleges directly.

- GCSE Maths tests: 20 papers covering all 3 Tiers, with answers, (£40.00)
- GCSE Non-calculator Revision Tests: 30 papers, classified by Attainment Target. £22.00
- A-Level Maths tests: sets of 10 papers per module, available as:

Following the London modular syllabus, £15.00 per set;

Based on the AEB syllabus, £20.00 per set;

Cambridge modular, £12.50 per set.

These are not publications of the boards and should not be taken to reflect their policy.

For fuller details and free samples, please write to me at the address below, stating which papers you are interested in and which syllabuses you take. If there are other papers which you feel should be available, or if you have written photocopiable materials which you would like considered for publication, please let me know.

Dr. David Fisher
DELPHIS Publications
97 Cannon Grove, Fetcham,
Leatherhead, Surrey, KT22 9LP
Fax: 01372-378860

Peer Support and the Maths Workshop

Peer support is students helping other students. It is particularly relevant to university life with modularised courses.

In FE colleges in particular, and increasingly in HE, an emphasis is placed on independent learning by students as money is diverted into IT resources and away from small tutorial sessions. Hence the growth of Maths Learning Support Centres (see John Brook et al, Issue 7, C. Patel in Issues 6 & 8, T. Croft et al).

A slowly growing realisation is dawning of the enormity of the cost to an institution of students dropping out. Moreover, students drop out when discouraged by one or two difficult subjects, such as maths often proves to be for business, computing, science, and engineering students.

Students hard pressed for money find part-time jobs and then have less time and energy to spend on taking enough time to understand a page of applied calculus problems.

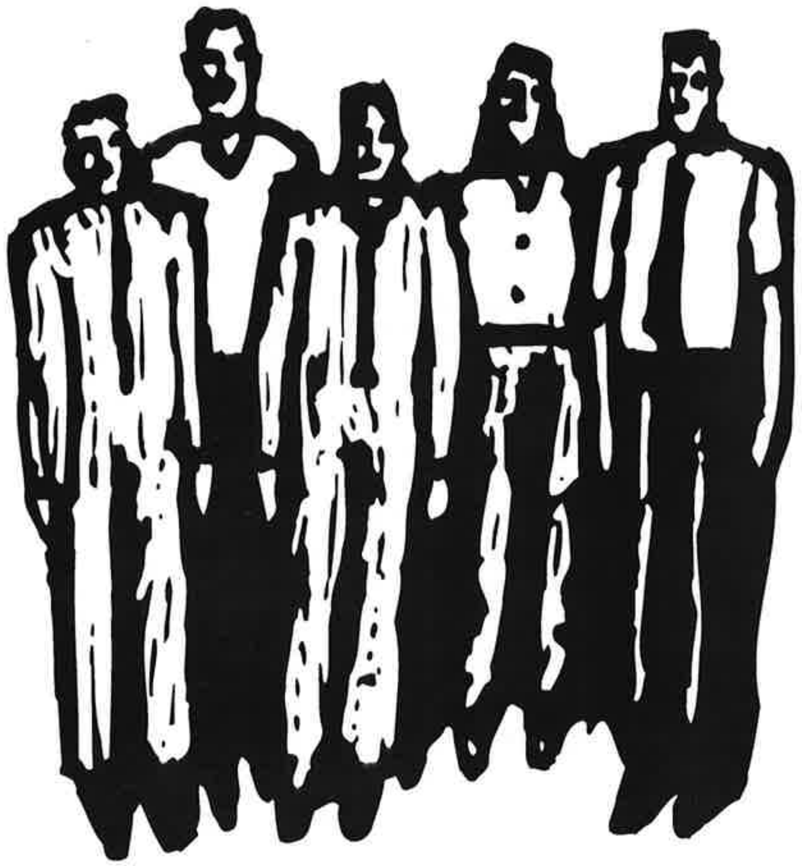
This might be alright if students managed their remaining time well. Euler is reputed to have boasted solving the Konigsberg problem with a baby on his knee and two or three more at this feet. However, most students need lots of time to learn these skills and there are few textbooks and fewer lectures which address this need.

Interestingly, the pamphlet on Maths Study Skills produced in the Midlands 20 years ago has just been revised by Pam Bishop et.al.. (She can be contacted at the CTI centre, which is attached to the University of Birmingham's Maths Dept.)

Peer Support has been applied to maths classes in different ways:

(1) Lecturers can instruct their students on day 1 that the class will be hard work. Then suggest that one way through the learning process is to work together in the maths workshop and to have small group discussions in class;

(2) Project work (Nottingham-Trent U.) where the task is assessed



on the final report and the quality of the group and its leadership is also separately assessed;

(3) Supplementing maths workshops/ suppport centres with student volunteers/paid workers, who are trained in facilitation techniques giving learners 1 to 1 sessions (Anderson, Issue 3...);

(4) The SI model (see below) where successful first year students are trained in facilitation techniques in September and then market and run support sessions. An interesting case study is the transferrence of SI from HE to FE when one of the first graduates of SI from Kingston University got a job in study support at Newham College in East London.

Peer support can be spontaneous or organised by academic staff. When organised, it typically involves some leadership by second or third year students who have successfully completed a difficult class or module and are therefore well acquainted with the student experience of it.

The focus is to put across relevant study skills to improve students' ability with understanding requirements and realities of that particular class/ module.

At the beginning, they offer help to get new students off to a successful start; demonstrating how email works, finding noticeboards and/or library, walking students through available resources, and managing time.

Later on, these sessions concentrate more on developing problem-solving skills and learning how to understand lecture notes and textbooks. Finally, exam passing techniques become important.

While many students who use Peer Support appreciate its informality and problem-solving emphasis, getting students to attend can be difficult.

Where it succeeds, lecturers can maintain high standards which turns out to be a pre-requisite for its success (the fear factor!). Moreover, they must expect their students to make use of it and support, or even train, the students offering it.

In FE, the fear of maths exams set by outside bodies is a given. In HE, first year students are reluctant to sign up for tricky modules unless they are mandatory. Staff are loath to develop peer support as it is difficult and also requires them to adjust their classes.

For example, it is to provide early feedback of the standards required. Yet if maths departments want to continue to offer maths as a service department, they must offer value for money. To do this, students must be successful both in meeting the demands of the course but also in developing understanding and skills.

Deliberations talks about offering peer support on the web as a means to address a wider range of problems. Maybe. The key issue for me is the possiblity of support which sticks with a learner while he/she is stuck and to force out acceptance of what is and is not understood.

Peer supported students bring with them to tutorials questions that have emerged during the support sessions. Listening to University of Leicester and U.C. maths students talk about their feelings learning maths, it sounded identical to the fears of Access students as they struggle with the core module of numeracy, which they must pass to go on.

Ian Beveridge, University of Luton,
Dept. of Electronics & Maths.

How SI Supports Student Learning

For Departments going through the next round of TQA subject assessment, SI is an ideal tool for demonstrating student retention, active student learning and feedback.

If you develop SI provision, it is usefully included in the self assessment document, which is sent in 6 months before the visit.

The ways in which SI supports student learning and academic development are indicated below in ways which directly relate to course content.

SI can contribute in the areas of:

1. CURRICULUM DESIGN, CONTENT AND ORGANISATION

SI as a learning resource
Supports knowledge and understanding
Cognitive skills development
Transferable skills
Personal development
Progression to employment
Helps monitor and review the learning outcomes and actual student achievement

2. TEACHING LEARNING AND ASSESSMENT

Student engagement and participation
Evidence on teaching through student SI leader feedback
Uses the course materials
Understanding the assessment criteria

3. STUDENT PROGRESSION AND ACHIEVEMENT

Student completion of the programme
Progression through the stages
Feedback from employers — enhanced skills of Leaders

4.STUDENT SUPPORT AND GUIDANCE

Induction using SI as buddies
Mention of SI in the course handbook / prospectus
SI offers academic guidance
SI Leaders refer students to relevant experts for other support

5. LEARNING RESOURCES

SI Leaders can advise on the appropriate use of resources
SI is a vital transitional and social support in learning how to learn in higher education
SI Leaders encourage students to be more independent in their learning
SI empowers students to engage with the subject

6. QUALITY MANAGEMENT AND ENHANCEMENT

SI encourages the use of student feedback
SI leaders are a visible and vocal advocates for deep and focused learning
Through student feedback, curriculum redesign might occur
SI is a staff development model also.

Written by Jennie Wallace
(Toddington College)
& Distributed by Maureen Donelan
<m.donelan@ucl.ac.uk>
http://www.ucl.ac.uk/herdu/

A Tale of Two Surveys

This article looks at two recent surveys researching how maths is supported for all those who learn mathematics in Further and in Higher Education.

The majority of learners require the subject for some other purpose than for an appreciation of the maths itself. Students entering HE courses that require a foundation of mathematics can be divided into two groups: prepared and under-prepared. These groups will have different support needs.

Likewise, in FE there are marked differences between GCSE repeats and AL maths students in their teaching and learning needs.

The first survey reviewed looks at transition needs for students in UK HE and was undertaken in 1999 by Trevor Hawkes at the University of Warwick (1).

The second survey is by Ian Beveridge at the University of Luton. It is a series of three undertaken in 1993, 1996, and 1999 on the support needs of lecturers delivering maths as a service subject in HE and in all parts of FE.

Transition needs of students

The Transition survey's target population was university departments whose students require maths beyond GCSE Higher.

One finding was that approximately 50% of maths, physics, & engineering departments required a diagnostic test of students' current maths skills on entry. No computer science department had a diagnostic test.

Another finding was that 90% of all responding departments claimed to offer teaching or tutorial support of 'pre-university maths'.

Diagnostic testing is used by a majority of universities to identify students needing remedial help and by a minority to inform the design of their courses.

	Mathematical Sciences	Physics	Engineering	Computer Science
Skills assessed	Core A level & specialised topics beyond	Algebra, Trigonometry, Calculus, Statistics.	Pure Maths core	n.a.
Length of test	40–60 mins	60 mins (mode)	Up to 1 hour	n.a.
Years in operation	80% recently 20% long time (i.e. about 5 years or more)	90% recently 10% long time	60% recently 40% long time	n.a.

Table 1: Diagnostic Tests

This suggests that most departments see the student as the primary problem rather than the educational system.

When so many students in engineering (2) can be labelled remedial, it is surely time to co-ordinate HE with FE and secondary sectors to reduce the 'transition' problem between GCSE and A level and both of these with HE.

The skills tested are an indicator of the knowledge expected by HE departments. It suggests that whilst secondary schools & FE colleges are able to make most A/L maths students familiar with the breadth of the syllabus, only a few are able to develop automaticity with algebra, trigonometry, and calculus procedures.

The different responses to the survey's questions on diagnostics testing are recorded in table 1. Students wishing to be mathematics specialists would benefit from knowing well ahead of time if a Further Maths A level is expected by the department where they wish to study their HE course.

Physics and Engineering students need deeper core skills than they have on entering HE although the problems here have been apparent for longer.

The absence of any diagnostic efforts by computing science departments stands out. It is explained away by the fact that the discrete maths required in computer science is not taught at secondary level and so has formed a legitimate module for first year classes.

The TLTP production of a video supported independent learning module in discrete maths by Brunel University is an example of this effort. However, Kingston University, who had offered peer support (3) for computer science maths modules subsequently found a 'solution' to the high failure rate of the course by making those maths modules optional.

It may be then that the failure of computer science departments to screen entering students' maths skills indicates complacency.

Table 2 summarises the questions on maths support that indicate a broad and shared range of intitiatives. The breadth of the initiatives is encouraging but their depth is discouraging.

Institutions that follow up diagnostic testing with individual support and integrating this work with the mainstream teaching programmes are notably few.

The modal or typical response of departments is to follow up a diagnostic test by streaming students into regular and remedial groups.

	Mathematical Sciences	Physics	Engineering	Computer Science
Taught class	New year 1 module for credit/ embedded in existing modules/ consolidation module	Same as for maths	Same as for maths and physics but also through a foundation year	New year 1 core module for credit.
CAL	Transmaths Mathwise CALMAT	CALMAT	Transmath Mathwise	Mathematica
Other support	Drop-in Workshops Short course workshops Second year peer tutoring Pre-uni top-up	FLAP self-study based on diagnostic result Drop-in work-shop with self-study materials Pre-uni top-up	Drop-in workshops Short course workshops Second year peer tutoring Pre-uni top-up	Drop-in workshops. Postgraduate tuition.

Table 2: Types of Remediation

Another noteworthy result of the survey is the revealed paucity of CAL initiatives. CAL where students are left on their own may not be cost-effective as so many students will not struggle hard enough or for long enough.

Andy Fitzharris at the University of Herts has in previous editions of this newsletter outlined the kind of effort and long-term planning required to integrated CAL successfully into mainstream provision for science and engineering students (4).

The second survey on Maths support (5) provides information on some of the Research Questions which conclude the Transition Maths survey.

What are the major shortcomings that require a bridge to HE?

Over 90% of lecturers at both old and new universities and also at FE colleges are of the opinion that algebra skills have distinctly worsened steadily over the last decade and lay some of the blame of the large numbers of students encouraged to take the GCSE Intermediate syllabus.

Over two-thirds of the HE lecturers find a decline in the range of algebra topics that are familiar to their students. Similar overwhelming agreement by both HE and FE lecturers is found on the decline of arithmetic skills and also on problem-solving skills (6).

On the pedagogical side, students' ability to learn independently from textbooks is regarded as miserable but that it has always been so. There have been efforts in the past to address the different study skills that are peculiar to maths. Indeed, a study guide first published at the beginning of the 1980's has been revised at the initiative of the CTI maths group this year (7).

This survey of students' maths skills found several areas of improvement that provide a basis for changes in teaching provision. Skills with technology, and in particular the use of graphing calculators and computers, have deepened and attitudes have become more positive.

My own experience of liaising with secondary schools has been to organise a maths problem-solving day for years 10, 11, and 12. The aim has been to motivate and interest students in maths. However, it has also lead to regular planning meeting with local maths teachers because it is they who deliver the circus problems on the day.

We have had three such annual events so far, and after the first one, we decided to make the application of spreadsheet solutions a priority in participating Bedfordshire schools. This effort has encouraged a noticeable change and in the third year we routinely have spreadsheet based approaches to solving problems in statistics, mechanics, and in algebra.

In general, lecturers felt that today's students were more open-minded and better motivated learners. Some felt this to be a two-sided coin whereby certain students would challenge provisional results needed to establish other parts of maths and thus slowing coverage of their syllabi.

Another hopeful finding is the greater willingness of students to talk about mathematics. Finally, the range, even if not the depth, of students' arithmetical skills is perceived as improving.

The shortcomings of maths lecturers and also of educational administrators and government were also considered in this survey. There were two broad classes of comments and there were a lot of comments.

The first group bemoaned the consequences of lowered contact hours and lessened support for learning maths as a result of continual pressure to save money. More classes for lecturers in FE and HE result when contact hours are reduced and a lecturer's overall teaching hours are not.

There is a sense of being overwhelmed by the extra preparation needed and a reluctance to put in the extra time to adapt the general teaching packages.

The second group of comments expressed a widespread feeling that more encouragement needs to be given to 16–19-years old than teachers feel able to give.

Many students sitting GCSE resits are angry; students with poor results have unrealistic expectations or are unaware of the effort needed before they can make use of their maths; maths is not seen as useful but more as an obstacle.

Poor attitudes to learning combine with an unbridged gap in the demands of maths at A level after GCSE at the intermediate level. Moreover, an increasing number of students wish to take A level having only completed a GCSE intermediate syllabus. Universities can help by placing greater emphasis on the merits of the GCSE advanced maths syllabi.

What changes are being made to cope with this situation?

The drop-in workshop has become a more common feature of maths support. Sometimes 'office-hours' have simply been re-named as 'workshop-hours' but often the drop-in workshop is a resource room for many other types of support. Both the frequency of bridging courses and the availability of Computer Assisted Learning (CAL) have increased.

There is anecdotal evidence of increased diagnostic testing such as Diagnosys in HE, and the ALBSU basic skills test used in FE.

While their availability as CD Rom disks exist, there is a concern about the efficiency of their use and how well integrated they are into mainstream teaching practice.

	Overall Rank 1996 (% of all depts.)	Overall Rank 1999 (% of all depts.)
Bridging Course	1 (62%	2 (68%)
Tutoring	2 (62%)	
Paper-based worksheets	3 (57%)	4 (50%)
Drop-in workshops	4 (56%)	1 (77%)
CAL	5 (53%)	3 (59%)
Diagnostic Testing	6 (50%)	
Videos	7 (31%)	
Year 1 modules of "pre-university" maths	8 (26%)	
Peer Assistance (organized)	9 (23%)	5 (26%)

Table 3: Types of Remediation by Frequency of Use

There is also anecdotal evidence of more year-1 numeracy modules, which can recruit large numbers of students from across all departments. Some, such as Gill Kerr at the University of Central Lancs. (8) and Marion Canham & Vivien Ferguson's at Cheltenham & Gloucester College (9), have affective as well as academic objectives.

Tony Grove at The Nottingham & Trent University collected bridging maths material from various Engineering Departments from around England that filled two storerooms! Some covered A level plus, such as those at Plymouth and Bradford Universities. Others were little more than numeracy basics.

I conducted a quick survey of web sites around the world by using the phrases: Math(s) Learning Centre (Center); Learning Support Centre (center); Maths Workshop; Drop-in Maths Help.

The impression was made that many Australian and American universities have formal zero credit bridging maths classes in support of mandatory for credit college algebra classes.

The compulsory aspect of these maths modules emerges from a view of 'Graduateness' overseas that includes the ability to reason in quantitative terms. This contrasted with the variety of efforts documented in Tony Grove's survey of what goes on in the UK (10). Sadly, this reflects back on the absence of mandatory maths modules, even for science students, in most of England's universities.

The provision of support varies also between institution types. Traditional universities offer more tutorials but a smaller variety of other support types. New universities are the strongest with computer technology and have embraced a wide variety of support types.

FE colleges have embraced paper-based open learning materials delivered through maths workshops and have clung less to the traditional lecture-seminar approach to teaching.

The current effort in developing maths resources seems to be (a) with diagnostic tools, (b) following up those tools with individualised work, and (c) integrating such work within mainstream teaching.

Where this is done, 'pre-university maths' is given credit and does not overwhelm poorly prepared students.

Other recent initiatives include WEB based interactive tutorials, using authorware, and various attempts at bridging maths programmes with school leavers.

The main problems include the growing gap in maths knowledge to be bridged; between GCSE and A level, and schools and HE. Short term economies closing down Learning Resources/ Maths Workshops affect both HE and FE.

There have been substantial closures of maths degrees since 1993, despite a slight increase in numbers taking maths at A level. Servicing maths modules by non-maths departments or the use of part time lecturers has meant less overall support for students outside of lecture hours.

How best can good practice be disseminated?

Peter Samuels outlined a philosophy statement for a maths support handbook (11) whose task was to disseminate good practice. In particular, it was 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."

In reply to this draft, Leone Burton (U. of Birmingham) wrote (12), "Resources do not do the learning job—they support it. In many cases, particularly with, for example, computer software, people appear to be thinking that if they just plug their students into a computer or a calculator, that will solve the learning problems they appear to have. It is simply not the case. Resources have to be used deliberately and with thought and discretion."

Philip Kent (Imperial College), adds (12), "Getting information on resources in action, from real users, is hard work. I'd prefer to see (have more thought given to) pedagogical depth — to see how the same resources have been used in different teaching/learning situations — and whether the claims of developers/publishers can be justified in practice."

He advocates a modular format for a Maths Resources Handbook so that it can grow section by section. Moreover, he advocates an HTML format on the grounds of its easy accessibility into programs that most people use.

Anne Hawkins (U. of Nottingham) defines effective learning in terms of a students' ability to apply novel concepts. The Statistical Education through Problem Solving (STEPS) software would be an example of resources for statistics teachers that focus on this aim (13).

Malcolm Swan (U. of Nottingham) has been investigating how GCSE resits are taught at FE colleges when information is made available about students' knowledge (in each topic). He has subsequently become interested in lecturer's perceptions of the way in which they teach and the contrast between their nominal commitment to active learning and their classroom practice. (14).

These surveys report the feeling of lecturers that we have fallen a long way down a slippery slope. John Lane (Newman College) reported after the first conference in Maths Support (1994) his impression: "dedicated enthusiasts struggling to cope with a desperate situation which is getting worse each year, usually with inadequate resources. Heartfelt cries — how do we cope with ever-larger classes and with ever-widening range of backgrounds?"

The new web site for this newsletter (www.luton.ac.uk/msa) has several case studies published in html format and wishes to develop material for free distribution (see this issue's centrefold spread).

Given an active interest from you, the reader, we can at least report your good practice!

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(7) *Study Skills for Mathematics – A Student Guide.* ISBN 0 86339-811 1 Sheffield Hallam University press.

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(9) *Putting Numeracy on the Modular Map.* MSA Newsletter No's. 1, 2, & 3 by Marion Canham & Vivien Ferguson (1994-1995).

(10) *Bridging Maths in Engineering* unpublished survey by Tony Grove (1993) for the Open Learning Foundation.

(11) *Basic Maths Resources Handbook.* MSA Newsletter No.4 (96) by Peter Samuels

(12) *Discussion on Maths Support Handbook* www.lgu.ac.uk/deliberations/math.support/Debate/ mrh_rep1. html

(13) STEPS (Stats Education thru Problem Solving) www.stats.gla.ac.uk/steps

(14) *Diagnostic Teaching* MSA Newsletter No.3 (95) by Malcolm Swan (Holding Back the Train Address at MSA seminar, Loughborough University Maths Learning Centre, Sept. 1998).

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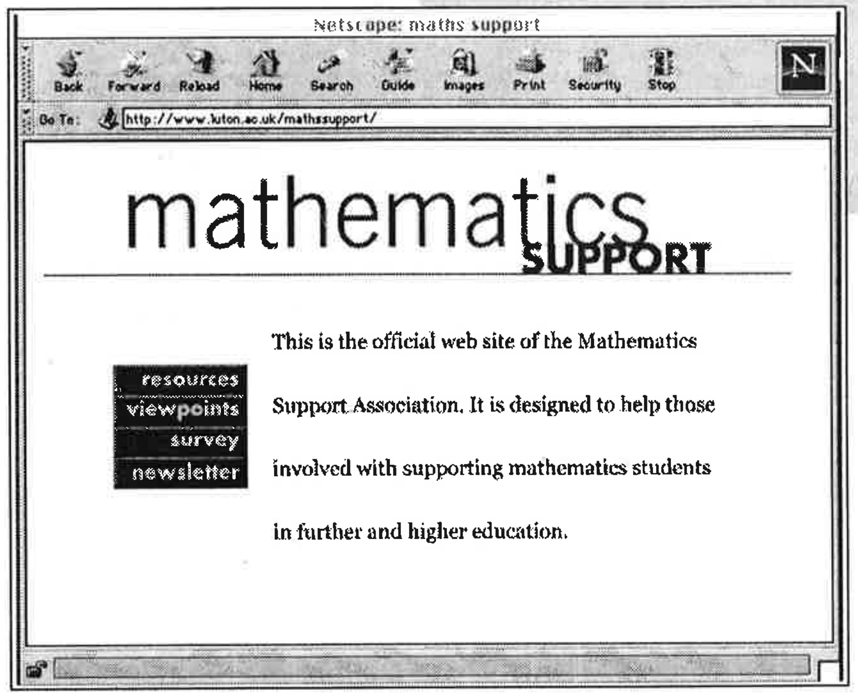

VISIT the Maths Support Association's new web site at www.luton.ac.uk/mathssupport

Our new web site includes a discussion page, useful links, back issues of the Newsletter, and a chance to participate in future surveys on mathematics support in your college.

We also plan to include freely downloadable resources like the worksheet in this issue of the Newsletter. Many of us have developed similar material. Please send in any worksheets that you have written and are willing to give away to a wider audience in supporting the learning of mathematics.

They will be edited, checked, entered on our web site, and summarised in the next issue.