

Centre for Teaching Mathematics News

Issue 1

December 2000



Welcome

Welcome to the first CTM News. We aim to publish this newsletter every half term and will distribute it to schools, colleges and interested people. If you are reading somebody else's copy please contact the Centre secretary to be added to the mailing list. The newsletter will contain information on the staff and activities of the CTM. Each issue will contain a teaching resource which might be a graphic calculator activity, a problem solving activity or a practical mechanics problem.

We are sure you are eager for the end of term and wish you all a good Christmas Break!

The Centre for Teaching Mathematics

The CTM is an inter-faculty group of mathematics educators based at the University of Plymouth within the Mathematics Department and the Education Faculty at Exmouth plus associate members.

The aims of the Centre are:

Creative Resources and Research

Training for Teachers

Mathematics Enrichment for Pupils

Who's Who?

The Plymouth Team

There are 13 members of the Centre Team at Plymouth all who have different roles. The Centre Director is John Berry and he is the team leader. Ted Graham is co-founder of the CTM with John and helps formulate the direction of the Centre. Jenny Sharp is responsible for the Mathematics Enrichment Programme and our Inservice Training Courses. Stuart Rowlands completed his PhD in 1997 and is now on the staff with a leading research brief and Stewart Townend is a

part time Research Fellow. We have one full time research student, Andy Smith and seven part time research students some of whom are practising teachers: Kathy Green, Carrie Headlam, Maxine Marcer, Peter McWilliam, Paulette Smith and Brian Walker, The sixth, Susan Picker, will graduate with her PhD in December. Keeping us all under control is the Centre Secretary, Julie Tombs.

The Exmouth Team at Rolle

Head of the Rolle Mathematics Group is Marion Gatrell, Alan McLean heads the Secondary Mathematics PCGE course while David Fallows, Duncan Graham, Peter Noon and Nick Pratt work on the BEd and Primary PGCE programmes. Nick Pratt is working towards his MPhil which is focused on the National Numeracy Strategy.

Associate members

Members of the CTM who are not based in the University include Roger Fentem from the College of St Mark and St John in Plymouth, Bob Francis from Exeter College, and Wendy Maull who was awarded her PhD in Engineering Students use of Mathematics in 1997.

Each issue will feature a 'Staff Profile' so that you can get to know the team.

Contacting Us

Members of the CTM can be contacted via the Secretary:

Julie Tombs

Centre for Teaching Mathematics

University of Plymouth

Plymouth

Devon

PL4 8AA

Tel/fax 01752 232772

Email jtombs@plymouth.ac.uk

Susan Picker

Susan Picker lives and works in New York City, where she is the co-ordinator of middle and high school mathematics staff development for a large community school district in Manhattan. She holds an MA from Columbia University's Teachers College.



In 1990 she attended Rutgers University's summer *Leadership Program in Discrete Mathematics* funded by the National Science Foundation, and soon began working as a lead teacher in the program. In 1996, having completed a small research study at Pace University in New York, on the effects of studying discrete mathematics on off-track high school students' attitudes, she decided she wanted to do further research.

Susan came to the Centre for Teaching Mathematics to be a research student in 1997 because of the strong record they have in researching learner attitudes and discrete/decision mathematics, both of which she hoped to investigate further. She had been using the Spode Group's *The Decision Maths Pack* by John Berry *et al*, with her students in New York for a number of years, but there was little similar material in the States at that time. "I felt a philosophical agreement with John Berry and colleagues at the Centre that I did not feel at universities in New York," she said.

Her project came to be an investigation of the images lower secondary pupils' hold of mathematicians and mathematics, which included an intervention utilising discrete mathematics. Susan was awarded her PhD in November 2000 and plans to continue her affiliation with the CTM as a research associate.

Part of Susan's research involved students drawing a mathematician and the pictures she obtained all had one thing in common - they were not at all complimentary! Two typical examples are shown here.

"Mathematicians," the pupil-artist wrote in a list accompanying figure 1, "have:

- No friends. (Except other mathematicians)
- Not married or seeing anyone.
- Usually fat.
- Very unstylish.

- Wrinkles in forehead from thinking so hard.
- No social life whatsoever.
- 30 years old.
- A very short temper."

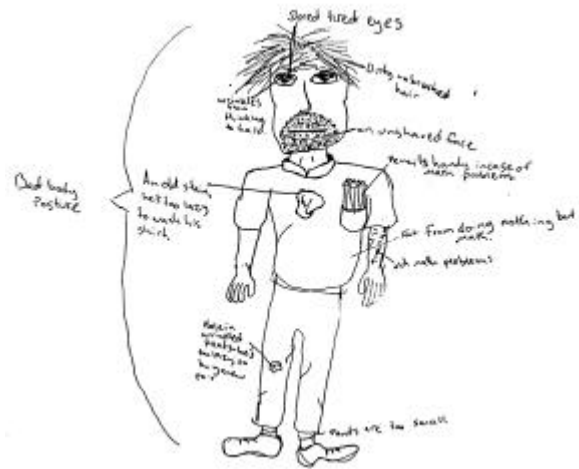


Figure 1



Figure 2

As teachers should we be concerned about our students views of mathematicians and mathematics? Find out what your students think by asking them to 'Draw a Mathematician' and answer some questions on what a mathematician does. There is a photocopiable sheet for you to use on pages 7 -8.

Susan is continuing her work and would be interested to receive some of the pictures and ideas. Please send them to Susan via the Centre for Teaching Mathematics in Plymouth. Susan can be contacted on email:

susan_picker@fc1.nycenet.edu

Mathematics Enrichment Programme

The aim of the MEP is to provide extra curricular mathematics for students of all ages, in particular those students who are able or interested in mathematics. We run activities and workshops for students from Primary through to VIth form.

The year started in September with the Primary schools and about 250 year 5 pupils (aged 9) from 50 schools throughout Plymouth and the surrounding area attended over three days. The pupils were challenged to different mathematical problems which were designed to stretch and stimulate the most able pupils. One activity was about measurement revolving around the tale of the burglar who left his hand print behind. All parts of the body can be measured by part of the hand and it was the pupils task to recreate the burglar from simply a handprint. Another activity introduced the concept of graphs by using a motion detector connected to a graphic calculator. The pupils were given the challenge to walk different graphs, each one introducing them to a new concept in graphs. Numbers and number patterns are an important part of developing good mathematical thinking and another activity investigated the patterns in moving frogs from one side of the pond to another!

Feed back from the schools indicated that such days are very rewarding for the pupils. It gives them an opportunity to mix with other bright children and to work together. Some comments from the pupils were *"I really enjoyed the day and I'm glad that they do it because you're learning without realising it because it is so interesting"*, *" I liked it because there were lots of people to talk to. The main reason I liked it was simple: I love maths and this was fun too"*, *" I thought it was a great day at the University - I wish school was like that! I really enjoyed the graphing, it was great fun, I would like to come again."*

The staff at the Centre for Teaching Mathematics relish working with the bright young pupils. It is very refreshing that they are so enthusiastic about maths and it is a pity that many will become disillusioned by the narrow constraints of the National Curriculum. Days like the Primary workshops go a small way towards maintaining their interest.

The next event in the Mathematics Enrichment Programme calendar are the Mathematics

Masterclass Series for year 9 students which start in January.

Members of the Centre are available to run workshops for individual schools for all years. For further details please contact the MEP coordinator, Jenny Sharp. (jsharp@plymouth.ac.uk)

Training Courses

We have many years experience of working with teachers of all levels on many different topics

- Teaching and learning mathematics with graphic calculators
- Teaching and learning mathematics with symbolic algebra systems i.e. DERIVE, TI-92
- Teaching and learning mathematics through modelling and investigations
- Teaching and learning mechanics through practical activities

Each Summer the CTM run residential training courses at the University of Plymouth. Details of this years are included with this newsletter.

In addition we are available to run courses at the request of schools and educational bodies. Courses can last from a few hours to a few days depending on the needs of the school. For example on a non-pupil day, the mathematics department of the school can have a day or half day training session as part of staff development. Alternatively if the school felt that the staff would benefit from a longer training experience, the course can be organised to run over a couple of days (not necessarily consecutive).

The location of the course can be at the school or college, in an Education Authority centre or conference centre. Often it is beneficial if a number of schools in one location join together for a course. This will provide participants to share experiences with new people and will also reduce the cost.

Texas Instruments are offering limited funding to support the training courses

which use their technology. Such courses need to be a minimum of two days with a minimum of 15 teachers. The sponsorship means that the cost to the school is greatly reduced. For example a two day course would cost a school around about £200.

For further details about training courses please contact the Inservice Course coordinator Jenny Sharp (jsharp@plymouth.ac.uk)

Research Projects

The Centre has four Research groups:

- Hand-Held Technology
- Mechanics
- Working Styles
- Student Centred Learning.

Each issue will give details about one of the Research groups in more detail.

Mechanics Research Group

The mechanics research group consists of Stuart Rowlands, Stewart Townend, John Berry and Ted Graham with three part time research students, Kathy Green, Maxine Marcer and Peter McWilliam. Kathy and Peter are full time teachers from King Edward VIth College, Totnes and Torquay Boys Grammar school respectively.

The research work into the teaching and learning of mechanics has continued to be an important aspect of the work of the Centre. The extensive investigations into the development of student understanding of concepts such as force and momentum have been used to provide a framework for developing strategies for improving student understanding. The main thrust of the work in this area over the past decade has been to use concept questions to challenge student 'misconceptions' of force and motion and to develop a qualitative understanding of the Newtonian system. Central to this work has been the use of parallel questions - questions that refer to different situations that have the same explanation within the Newtonian system as the original concept question. The process of asking concept and the associated parallel questions is both diagnostic, in that it reveals the misconception, and remedial in that it leads to an understanding of the target concept.

There have been literally hundreds of papers published over the past two to three decades of

international research in student misconceptions of force and motion. During the 1980's it was fashionable to speak of these misconceptions as if they were developed out of the child's interaction with the physical world - but with no explanation as to how this was possible. During the 1990's it was fashionable to speak of these misconceptions as if they were formed from the use of the term 'force' as a metaphor in everyday language (e.g. the 'force' of an argument) - but with no explanation as to how force as a metaphor bears any relation to force as a misconception in mechanics. We have published a paper ('Can we Speak of Alternative Frameworks and Conceptual Change in Mechanics'), in a very prestigious international journal (Science & Education, 1999, 241-271), which argues that misconceptions of force and motion may not be formed until the student is asked to consider concept questions concerning force and motion for the first time. In other words, misconceptions are not formed in the way that was previously thought by researchers. We are currently running a research project that is based on this argument, involving the three part-time MPhil students. Using the technique of clinical interviews, Peter McWilliam is researching how concept questions evoke misconceptions and how parallel questions can lead to the target-concept. Maxine Marcer is using and applying these results within a classroom context and Kathy Green is investigating the assumptions that have to be made by A-level mechanics students in the understanding of concept questions (with dyslexic students in particular).

For more information about the mechanics research group please contact Stuart Rowlands (srowlands@plymouth.ac.uk)

Do you like the idea of research in Mathematics Education?

We at present have six part time research students who are also full time teachers. If you feel that you like the idea of obtaining an MPhil or PhD in an area of mathematics education then please contact John Berry for an informal chat. (jberry@plymouth.ac.uk)

The Answers are not the same!

Do the following sums first in your head and then on the calculator.

1/ Calculate	In head	On calculator
(a) $8 + 2 \times 3$	_____	_____
(b) $8 + 3 \times 2$	_____	_____
(c) $2 + 3 \times 8$	_____	_____

Are the answers on the calculator the same as what you do in your head? _____

What is the calculator doing?

- (a) $8 + 2 \times 3$ _____
 (b) $8 + 3 \times 2$ _____
 (c) $2 + 3 \times 8$ _____

2/ Calculate	In head	On calculator
(d) $40 - 10 \div 5$	_____	_____
(e) $52 - 8 \div 4$	_____	_____
(f) $45 - 6 \div 3$	_____	_____

Are the answers on the calculator the same as what you do in your head? _____

What is the calculator doing?

- (d) $40 - 10 \div 5$ _____
 (e) $52 - 8 \div 4$ _____
 (f) $45 - 6 \div 3$ _____

3/ Calculate	In head	On calculator
(g) $5 + 7 - 3 \times 4$	_____	_____
(h) $4 + 2 \times 6 \div 3$	_____	_____
(i) $24 - 8 \div 4 + 2$	_____	_____

What order does the calculator do the calculations? _____

To get the calculator to give us the same answers as we get when we do the sum in our head we can use brackets. The calculator does what is in brackets first.

4/ Put brackets in to get the answer that you get when you work it out in your head. Try it on your calculator to see if you are right.

- | | | | |
|----------------------|------|-----------------------------|------|
| (a) $8 + 2 \times 3$ | (30) | (e) $52 - 8 \div 4$ | (11) |
| (b) $8 + 3 \times 2$ | (22) | (f) $45 - 6 \div 3$ | (13) |
| (c) $2 + 3 \times 8$ | (40) | (g) $5 + 7 - 3 \times 4$ | (36) |
| (d) $40 - 10 \div 5$ | (6) | (h) $4 + 2 \times 6 \div 3$ | (12) |

5/ Decide where to put brackets so that the calculator gives the answer shown.

- | | |
|-------------------------------|-----------|
| (a) $13 + 5 \div 2$ | answer 9 |
| (b) $5 + 3 - 4 \times 7$ | answer 28 |
| (c) $48 \div 6 + 2$ | answer 6 |
| (d) $48 \div 6 + 2$ | answer 10 |
| (e) $11 + 1 - 5 + 6 \times 2$ | answer 19 |

The Answers are not the same!

Hints and Answers

This activity is designed to encourage the appropriate use of brackets in writing arithmetic expressions and to see that the calculator has a priority in carrying out operations. The calculator used here is the TI-83 but any graphic calculator (or two line display calculator) that follows the correct mathematical order will do.

Answers

1/ The calculator gives as shown. Most students will expect 30 for the first expression, 22 for (b) and 40 for (c). When doing this by hand students often work from the left adding first and then multiplying. Encourage them to see that it is doing the multiplying first.

$8+2*3$	14
$8+3*2$	14
$2+3*8$	26

2/ Here the students will probably get (d) 6, (e) 11 and (f) 13. Again they should realise that the calculator is doing the dividing first.

$40-10/5$	38
$52-8/4$	50
$45-6/3$	43

3/ (g) 36, (h) 12 and (i) 6 is probably what most students will get in their heads. Getting the students to work out what the calculator is doing will enable them to come up with the order of operation.

$5+7-3*4$	0
$4+2*6/3$	8
$24-8/4+2$	24
■	

Multiplication or Division then Addition or Subtraction

Encourage the students to come up with a mnemonic to remember the order: My Dear Aunt Sally is a well known one, students have vivid imaginations so you will get all sorts of ideas.

Introduce the idea of brackets to get the calculator to do things in the order that you want, now the order is BMDAS, another chance for silly sayings!

SIDE 1: PLEASE COMPLETE THIS SIDE BEFORE SIDE 2

What do you think a mathematician looks like?
In the space below draw a mathematician at work.



SIDE 2: PLEASE COMPLETE AFTER SIDE 1

I am: Female Male

- | | strongly
agree | agree | not sure | disagree | strongly
disagree |
|-----------------------------------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. I enjoy my mathematics classes. | 1. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. A mathematician's work looks like fun to me. | 2. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. I would never think of becoming a mathematician. | 3. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. I usually feel confident in maths classes. | 4. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. I plan to stop studying maths as soon as I can. | 5. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. I have met a mathematician. | 6. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

(if you answered **strongly agree** or **agree** to #6, who is the mathematician you have met?

_____.)

- | | | | | | |
|-------------------------------------------------------------------------|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 7. Mathematics is not a subject where I get to express my own opinions. | 7. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. I look forward to doing more maths in school. | 8. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Mathematics is the study of numbers. | 9. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. I see myself as a mathematician. | 10. <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
11. If you have a leaky tap, you need to hire a plumber; if you break your leg, you need the services of a doctor. List below all the reasons you can think of for which someone would need to hire a mathematician:

12. Look back at the drawing you made of a mathematician at work and write underneath it an explanation of the drawing so that anyone looking at it will understand what your drawing means, and who the persons are in it.

13. (*Please complete this sentence:*) To me, mathematics is:

Please return drawings and questionnaires to
Susan Picker, Centre for Teaching Mathematics, University of Plymouth, Plymouth, Devon
PL4 8AA