
MSOR Workshop Reports

Workshop on the *Mathletics* online objective tests, Brunel, 8 May 2003 Report prepared by Dr Jo Morgan, University of Reading

The workshop began with a demonstration of the *Mathletics* package, which is a set of web-based tests designed to give students the opportunity to practice their maths skills, with the advantage of immediate feedback including worked solutions. After a brief introduction, Martin Greenhow, the author of the package, started the session in a computing lab giving the group the opportunity to experience *Mathletics* first hand. A powerful tool available is the analysis of tests. *Mathletics* allows you to identify both individual and group weaknesses in a particular area, allowing suggested further study to students and lecturers quickly and easily.

Next came a demonstration on how *Mathletics* is constantly developing. Using Perception, questions are now being written that are realised at runtime. This includes worked solutions, mal-rules, questions that follow through workings and even graphics. Once all the hard work has been invested on writing a question, working out exactly what skills are required, possible mistakes that are likely to be made (mal-rules) and what feedback is required for each response, Perception pays off that investment by allowing the actual numbers used in the question only to be decided randomly when the student attempts the quiz. This gives the student the advantage of being able to practice the same skills until they are confident, and also reduces the risk of copying

if the marks collected are to be used for assessment purposes. The discussions that followed highlighted the possible pitfalls and dangers of setting such questions. These included being clear what it is you are testing and the care required when using randomly generated numbers.

The feedback from students using the package was positive and the day concluded with group work at writing our own multiple choice/response type questions. The day provided a useful insight into using Perception, and particularly with the templates provided from the workshop, how to start writing objective multiple choice style questions.

Assessment Symposium: Testing Times, Edinburgh, 16 May 2003 Report on workshop prepared by Pam Bishop

This one-day symposium brought together 22 university teachers from 15 institutions who have met the challenge of assessment in its broadest sense and are delivering some innovative solutions. The day sought to discuss some of the ideas being used around the UK and concluded with a debate on the motion "*This House believes that e-Assessment is the answer to the problem of educating the next generation of mathematicians*".

1. *Online assessment in practice* *: Manolis Mavrikis, Edinburgh

Manolis described the Wallis system which was designed to support students learning mathematics as part of science and engineering courses. Interactive modules have been developed in Mathematical Methods, Applicable Mathematics and Geometry, Iteration and Convergence. The system employs multiple choice, multiple response, matrix and fill-in-blank questions for self-assessment, as well as Java applets for exploration. An area at the bottom of the screen gives contextual help and 'intelligent' feedback according to students' actions and answers while they work with the activities. Additional care has been given to provide a friendly user interface and ease the input of mathematics. More formal assessment is being introduced in a similar format. A randomised assessment with multiple parts was allocated to students over the Easter vacation. Students uncomfortable with the interface could print it out, work

offline and then input the results. The automatic marking system made use of Maple/Java to follow through any errors made by the student during algebraic calculations. In this way marks could be given for methodology even if the final answer was not correct and the system produces transcripts with feedback tailored to their individual answers and misconceptions.

Principles for giving effective feedback have been studied in order to incorporate them into Wallis. At present authoring is very time consuming, and work is being conducted so as to re-use content and questions from other systems (such as AIM) and conform to and extend accepted standards (IMS QTI, OpenMath).

Student input of math expressions is a particular problem for our discipline. It can be done via an equation editor or as a string like $x^3/(x+2)$. Dynamic input tools that show how the string is being interpreted increase traffic between the client and the server and this can slow

down the whole network. The Wallis input tool avoids this by parsing and displaying the expression on the client machine.

2. *Assessment with a Purpose in Statistics* *: Peter Holmes, Nottingham Trent University

Peter summarised some weaknesses in current assessment practice: tasks may not match stated outcomes; criteria may not match tasks or outcomes; criteria may not be known to students, or they may not understand them; overuse of one mode of assessment; overload of students and staff; unduly specific criteria which create a straitjacket; inadequate or superficial feedback (from Brown, G (2001) *Assessment: A guide for lecturers*)

Assessment has many purposes but fundamentally it should be to ensure that students have learned and can apply what they have learned. As we have to link learning outcomes to assessment, the outcomes will be worded in terms of how we assess. If there are things we can't assess, we can't put them in an outcome, and don't have them as an expressed aim of our teaching. In statistics, even at school level, we would want students to be able to carry out each aspect of the handling data cycle to solve problems:

- specify the problem; formulate questions; decide on data; what analysis to do; consider inferences
- collect or obtain the necessary data by appropriate survey, experiment or from secondary sources
- process and represent data; turn data into useable form
- synthesise information and interpret results

The vocabulary of learning outcomes is limited to active verbs that are capable of being interpreted objectively. This precludes the use of words like "understand",

"appreciate", "discover" or even "think". This is not necessarily a good thing; there are ideas behind these words which are worth trying to tease out into learning outcomes. Peter suggested a hierarchy of words, culled from various sources and based on Bloom's taxonomy of educational objectives. He matched these with some relevant assessment modes in Table 1.

3. *Supporting Good Practice in Assessment in MSOR* *: Neil Challis (Sheffield Hallam) and Ken Houston (Ulster)

In established disciplines such as Mathematics, Statistics and OR with well rooted culture and traditions, generic booklets about good practice in assessment such as those produced by the LTSN Generic Centre, do not often receive wide attention. The speakers, along with David Stirling (Reading) have been commissioned by the LTSN Maths, Stats & OR Network to represent and exemplify some of these generic assessment ideas in the context of MSOR, and disseminate the ideas through subject specific booklets and otherwise, supporting initial and continuing professional development. The booklets will have the following titles:

Assessment in Maths, Stats & OR: A Guide for Lecturers and Heads of Department – alignment, learning outcomes, purposes principles and methods.

Assessment in Maths, Stats & OR: A Guide for Students – written for students, this can be used directly or perhaps to inform or stimulate review of an existing student handbook

Assessment in Maths, Stats & OR: briefings on some issues and examples

- **Key Skills** – what are they, and how can they be assessed

- **Portfolios** – what are portfolios and progress files, how can evidence be collected

Level of understanding	Active verbs that can be used in learning outcomes	Relevant assessment modes
Knowledge	Define. State. List. Recognise. Show. Label. Name. Identify.	Quiz. Part exam question.
Comprehension	Explain. Clarify. Discuss. Review. Describe. Recognise.	Multi choice. Assignment. Exam
Application	Demonstrate. Use. Calculate. Estimate. Fit. Implement.	Coursework. Apply specific techniques to particular problem.
Analysis	Investigate. Solve. Interpret. Explore. Analyse. Explain. Compare. Contrast.	Analyse a data set. Oral presentation. Case studies. Analyse computer output.
Synthesis	Design. Formulate. Model. Improve. Adapt. Develop. Construct. Devise. Combine.	Design and carry out an investigation. Prepare a report & present. Essay. Open ended questions.
Evaluation	Assess. Criticise. Contrast. Review. Distinguish.	Critically assess others' projects. Defend own presentation.

Table 1 Bloom's taxonomy of educational objectives matched to assessment modes

- **Key Concepts in Maths, Stats & OR Assessment** – educational terminology explained
- **Self, Peer and Group Assessment** – why and how to involve students in their own assessment
- **Plagiarism**
- **Work-based Learning**
- **Assessment of Large Groups**

The talk summarised progress so far on all but the last three, and sought dialogue about the continuing project. The online progress file system at Sheffield Hallam was demonstrated; in every module students are expected to make an entry every week, giving rise to a record of achievement with evaluative comments.

4. *Using VLEs for Assessment in Mathematics and Statistics* *: **Bill Foster (Newcastle)**

Bill has been involved with a project at Newcastle to use Blackboard in conjunction with computer-aided assessment in a second semester maths and stats module at foundation level. Transmath had already been used for CAA at this level, but it proved impossible to integrate into Blackboard, so the assessment had to be done as a parallel exercise and the results transferred by hand. At the same time video cameos (extracted with permission from the Maths4Engineers project) were introduced into the Blackboard environment. The project showed that students appreciate the e-learning environment as long as the assessment engine is reliable, the input of mathematics is user-friendly, feedback is available, and there is access at all times. With regard to the VLE, technical issues regarding registration must be dealt with otherwise lecturers will lose faith in the system and stop keeping their resources up to date.

Through the separate INFORM-IT project, funded by the LTSN Maths, Stats & OR Network, Bill is investigating the use of online methods in teaching mathematics and statistics across the UK. Although VLEs and other online tools are now widespread in HE there is evidence that take-up and use by staff in numerate disciplines has been limited. This is partly caused by lack of belief – a substantial number of staff feel there is no evidence for major benefits to be gained from using web-based methods, and that the best way for students to acquire skills is through practice in small tutorial groups. Even if lecturers are interested in developing online courses, there are significant obstructions due to lack of time, little incentive and poor support. Presenting mathematical notation on the web is also perceived as an obstruction, particularly in relation to online

assessment. However, there are tools now available which make this presentation possible.

Ongoing work in this area includes the development of assessment engines which can handle mathematical input and their integration into VLEs. This is being done at Birmingham (AIM into WebCT) and Newcastle (i-assess into Blackboard). If successful students could be provided with the opportunity to carry out any amount of practice providing there is a parallel development of good feedback and advice mechanisms.

5. *This House believes that e-Assessment is the answer to the problem of educating the next generation of mathematicians*

The motion was proposed by Neil Pitcher, who argued that e-assessment will be important to every subject, so that mathematicians cannot ignore it. 20 years ago the web had not been imagined and in 20 years time there will be other technologies. Students may be able to input responses by talking to a computer; small seminar classes may run as a videoconference, there will probably be no more problems with student authentication. Mathematics is seen as a difficult discipline and as such is under threat, whereas electronic media are pervasive – we must respect the culture of our students and adapt to it.

No-one had agreed to oppose the motion, but the following points were raised in discussion:

- authoring questions used to take 10 times as long on computer as by hand, but now becoming much more efficient
- intelligent feedback needs to use artificial intelligence techniques and may never match the memory bank of the human brain
- HEIs like the idea of e-assessment and think it's efficient, but student groups are becoming less homogeneous and need more personal help
- school students need to be wooed and the curriculum made more popular, to raise the profile of mathematics
- initiatives like PopMaths pub quizzes and popularisers like Tom Roper must be supported
- perhaps we should be dropping topics like calculus and introducing discrete mathematics

The symposium concluded with a vote of thanks to all the speakers and especially to Neil Pitcher for his inspiring view of the future.

* Resources from this and previous workshops can be found on our website via <http://ltsn.mathstore.ac.uk/workshops>

**Virtual Learning Environments – Potential and Pitfalls, Newcastle, 17 June 2003,
Report on workshop prepared by Pam Bishop**

This one-day workshop brought together 21 university teachers from 13 institutions. It covered three basic themes: web based assessment in VLEs; discussion forums and group tutorials across the web; and feedback and monitoring using a VLE. Two of the sessions overlapped with those featured in the Assessment Symposium held a month earlier in Edinburgh and reported above.

**1. Teaching and VLEs: The Northumbria experience *
– Malcolm Bell**

Malcolm has been a maths teacher and a teacher trainer and is currently responsible for the implementation of Blackboard at Northumbria University. From a standing start in February 2001, more than half the academics staff are now involved, supporting some 2,000 Blackboard sites and servicing over 20,000 students. The sites vary from providing simple information and supporting access to course materials through to online delivery to communication and collaboration areas. There is a range of approaches across all subjects; mathematical applications include assessment (automatic marking and mark storage), a basic equation editor, electronic submission of assignments and links to mathematical web pages including past exam papers.

Creating quality materials is not cheap – a 10 credit module costs £45,000, and staff need support in acquiring the necessary IT skills. However team preparation of materials creates collegiality. Students are the main drivers in improving the system – they are taking ownership of their own learning and looking for seminars rather than lectures. They also notice disadvantages such as having to pay for printing out materials. Mature students may also lack IT knowledge and skills, and slow access over a home modem militates against the ideal “of being able to study anywhere”. These effects need to be borne in mind by the institution in developing the system further.

**2. Online Tutoring Pilot Study in Scotland * – Mike
Steel, Heriot-Watt**

Online and printed materials developed under the SCHOLAR project to support Highers and Advanced Highers are freely available to schools throughout Scotland. These are funded by the local education authorities (LEAs) and thousands of students are involved. Each school has a SCHOLAR coordinator, but many only use the printed materials. Online tutoring to support the materials is being piloted in four LEAs and four subject areas. The sixteen tutors involved were recruited from local teachers to set up and support dedicated discussion boards. In fact only two achieved

a high response rate. Factors like isolation of students, under-resourcing in schools, and training of the students to use the online materials were in fact less important than the approach and enthusiasm of the online tutors and the use that the teachers made of the online materials in the schools. It is hoped to address this in the next stage of the pilot which will start with the next school year.

**3. Using a VLE to incorporate discipline specific
elements in an induction programme – Warren
Gilchrist, LTSN Maths, Stats & OR Network**

Institutions currently offer accredited initial or continuing professional development courses for university lecturers in a generic format. “Teaching Statistics” is a set of distance learning and e-learning material to support and develop the skills of university staff in teaching statistics, assuming they already have some training/experience in generic teaching skills. It is structured in six units that can be used flexibly and corresponds to 20 credits of a PGCert/Diploma programme. Thus it can be embedded within a university’s induction programme or used independently. Five of the units are provided as printed booklets, and the sixth is internet-based. The units are supported by resource packs of illustrative material, a Reader and a website in a Blackboard environment. The material is available for use in 2003/4.

**4. Observations on using a VLE to engage students *
– Joanne Smailes, Northumbria**

Joanne reported on an action research project which investigated using the Blackboard facility for computer-aided assessment (CAA) within a business modelling course. A set text is linked to ten quizzes. These are automatically marked with immediate feedback and are seen as formative assessment; however three of these are randomly selected to contribute a small percentage to the end of year mark. Students were then surveyed on their attitude to the method of assessment and their approaches to learning. Allowing for demographic differences it was found that provision of immediate feedback can move students towards deeper learning and in fact the results of the module showed a distinct improvement on previous years. The study also found that students would value later feedback on the

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achievement of the whole group and that this would provide further motivation. Again slow access to e-learning materials across a home modem was an issue.

5. A brief history of CALM * – Cliff Beevers, Heriot-Watt

CALM (Computer Aided Learning Mathematics) activities have been well documented at the website <http://www.calm.hw.ac.uk>, and Cliff summarised various milestones in its development. The latest project under the name of PASS-IT is piloting the delivery of CAA into Scottish schools. This involves a number of agencies – SCROLLA (Scottish Centre for Research into On-Line Learning and Assessment), LTScotland, Scottish FE Unit, Scottish Qualifications Authority and the BBC – who are preparing automatic assessment material to test lower order skills in school and college qualifications, and training staff to implement it. Traditional examiners are working with CAA experts and mathematics is among the first subjects to be included. Implementation will happen first at Higher and Advanced Higher level, then it will be extended to 5-14, Access and Intermediate.

6. VLEs and assessment of Mathematics and Statistics * – Bill Foster, Newcastle

(see para 4 of Assessment workshop report above)

7. An Overview of AIM * – James Blowey, Durham

James was given a Teaching and Learning development grant by the University of Durham to develop material within its Blackboard system. The mathematics department at Durham has its own server, and all first and second year lecturers will aim to get linked into Blackboard from October 03. Maple is currently taught in two first year free-electives and will be embedded into the first year from October.

The freely available Alice Interactive Maths (AIM) can be used as an assessment tool both for the use of Maple and for the mathematical course content. Since it can interpret algebraic answers, partial credit can be built in – marks can be reduced say by 15% each time a limit is given or a wrong answer overwritten. It is easy to use

and two third year students will be writing quizzes for some second year modules as part of their project. James is working with other members of the AIM community, and particularly Gustav Delius at York, to share practice and documentation.

8. Authoring activities, questions and other content for an ILE * – Manolis Mavrikis (Edinburgh)

see para 1 of Assessment workshop report above)

9. Discussion: is it worth it or do VLEs divert attention away from real teaching

What does a VLE offer over and above a normal web server? Administration of marking is a definite plus, and the possibility of more intelligent feedback; graphics, audio, video and even videoconferencing.

Other points in favour of using VLEs were that residential and distance learners get more equal opportunities to access materials and be part of a community. At Sheffield a WebCT MSc course in stats is coming to end of its second year, and can envisage that future residential students will eventually be expected to do tutorials online. For historical reasons the Open University has lots of different interfaces, and can see the benefit of a developing a common interface through a VLE.

Staff at Heriot-Watt have noticed the need for a different approach but the Physics staff now like Scholar, and are using distance learning materials even for students on campus. This results in students doing many more examples – 10 quizzes per term. There is a similar experience at Newcastle; a non-lecture workshop course based on Blackboard materials and CAA was enjoyed by students. The following year they had a more traditional delivery and some regressed.

There was a discussion of the relative merits of different authoring systems for questions. Templates with commercial systems are not so easy for academic staff to use; they find it faster to use a word processor type of editor. This has to be balanced against the effort needed to develop the editor.

Since the workshop we have been sent information about the Canadian system Nautikos which claims to have features beyond those of Blackboard and WebCT, and which is being offered to UK mathematics departments in return for a formal evaluation. Contact us if you are interested.

Someone once said that in ten years time we'll wonder why we spent so long requiring students to be confined to learning in the same time and same place as tutors. However, as the report above shows, many lecturers don't rate current VLE particularly highly. Many HEIs have invested in products such as WebCT or Blackboard and have been encouraged to add their courses, but because the systems are not tutor-friendly, the process has often been frustrating.

Altius (www.altius.org.uk) is setting up some evaluative trials in the UK of a Canadian system, Nautikos, that appears to be far more effective and much less frustrating than WebCT and Blackboard, and invites expressions of interest from UK HE Maths departments. The system would be made available for the delivery of maths courses in return for a formal evaluation.

There is a veritable plethora of learning systems in distance

learning, but what makes Nautikos seemingly superior to other learning systems is its coherence. It seamlessly integrates pedagogy, course delivery in any environment, (with or without the internet), tracks student progress and simplifies course administration. Most importantly it brings about demonstrable learning gains without causing lecturers angst when mounting courses.

In addition to all the usual VLE elements, the Nautikos system also provides controlled access to a wide range of courses, course materials and learning resources in any format (paper-based, digital, web-linked material); pedagogical mapping to learning programmes, learning resources, curriculum materials and learning support; wide range of delivery modes (online, synchronous, asynchronous, at or away from computer); Tracking student progress (summative and formative), as well as direct communication between tutor and students using voice over IP. It also has a dedicated mathematical whiteboard and

equation editor, so the student can be working on an equation using the interactive whiteboard - yet the audio link enables constant interaction - help can be requested when it is needed and the teacher can discuss progress. That simply is not possible using traditional distance learning techniques.

We hope to begin evaluating the system by the start of the new academic year, so if you would like to be considered for an evaluative trial please contact me as soon as possible. I envisage that existing maths courseware would be utilized initially to assess the overall extent of learning gains, but there will be opportunities for local level customization for those who would like to explore that aspect.

More information can be provided on request to John Castleford, email john@altius.org.uk. A downloadable demo is also available from <http://www.OdysseyLearn.com>



**Sharing of Projects Practice
Day workshop
University of York
Wednesday 12 November 2003**

Overview

Much of teaching and learning in mathematics is provided using traditional lectures and assessment is examination dominated but an area that has great potential in learning both mathematical skills and graduate skills are substantial project activities. Such project activities are also highly rated by graduates and their employers. Within undergraduate BSc and Masters programmes the provision of final year projects are typically available but often constrained by the demands on resources in defining project briefs, support of students and assessment issues. However, sharing of best practice in effective management, support and assessment could provide a means to minimise the staff resources required and to maximise the student learning experience and their attainment of project skills.

For staff familiar with project activities the investment in staff-time and required expertise is often considerable and the issues surrounding assessment has resulted in a generally patchy provision. The QAA Subject Overview noted this as the greatest weakness although a number of (un-named) Institutions have been accredited as having good provisions.

This workshop is aimed at sharing practice for the implementation, support and assessment of final-year project-based activities. An outcome of the day will be to establish commended practice in key areas for wider dissemination.

Organisers

Stephen Hibberd, University of Nottingham
Niall Mackay, University of York
Pam Bishop, LTSN Maths, Stats & OR Network

Programme

- 10.30 Coffee and Registration
- 11.00 Presentation Session 1 - project initiatives
- 12.45 Plenary discussion
- 1.00 Lunch
- 2.00 Presentation Session 2 - assessment of projects
- 3.00 Group discussions (3 groups)
- 3.45 Brief feedback from group discussions
- 4.00 Depart

How to Register

If you would like to register for this event please complete the online form or contact Jenny Nolan, LTSN Maths, Stats & OR Network, The University of Birmingham, Edgbaston, Birmingham, B15 2TT, phone 0121 414 7095, email info@mathstore.ac.uk

Bookings should be confirmed by post with payment in advance - the cost is £35. Cheques should be made out to "The University of Birmingham".

More info at:

<http://ltsn.mathstore.ac.uk/workshops/projects03>