USING THE WEB TO ENHANCE STUDENT LEARNING

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ABSTRACT

When mathematics interacts with technology, the possibilities of usage are vast. Technology can affect the way mathematics is done. It can also have a profound effect on the way that we as academics manage our teaching, carry out assessment and interact with students. The web provides exciting opportunities which can significantly enhance the quality of the learning and support which our students experience, whilst still maintaining the personal contact so necessary for a complete education.

We present here some of our recent experiences in implementing a range of initiatives concerning the use of the web with mathematics undergraduates, as part of curriculum innovation involving the integrated use of technology both for doing and for learning mathematics. The particular unit reported here involves the explicit critical study of mathematical technology, at first year undergraduate level:

Matters arising have included:

- Full material support for each unit provided on the web.
- Communication networks (lists, discussion groups, etc)
- Automatic monitoring of student activity on the material of the unit
- The need for a new approach to assessment

This final point warrants further discussion. Traditional approaches to assessment of mathematical activities most frequently involve an examination, with a pass mark of typically 40%, but little other feedback available to the student. This would be entirely inappropriate in this context because of the wide variety of skills to be assessed. We had adopted a novel approach in which the students may score up to 1000 points. Some marks are available for particular activities such as evaluating a piece of software, but students also accumulate a small proportion of marks week by week by completing a continuously-monitored online learning diary. Thus as part of the approach, students acquire a marked profile of their range of skills and experience, and automatically receive a high degree of feedback on their progress.

Keywords: TECHNOLOGY, CURRICULA INNOVATIONS, INNOVATIVE TEACHING METHODS

Introduction

As academics in higher education, we are faced with the problem of trying to deliver high quality courses with ever-diminishing resources. Direct contact time with students is limited, and we must find innovative ways both of using that time and of exploiting technology to support those students at other times. Motivation is also an issue - students will only really commit themselves to a topic if it is likely to be assessed. This tends to lead to a surface learning approach. By changing the assessment pattern we can, perhaps, go some way towards a deeper learning approach, at the same time giving the students essential skills which are valued in particular by employers world wide (Challis and Gretton 1999 and 1997, Davis 1991, Gretton and Challis 1997). In this presentation, we wish to report some preliminary results of our experiences using a variety of web-related support tools with a first-year group of undergraduate students.

Using the Web to Provide Basic Resources

At the most basic level, the web can be used to provide a library for course materials. In the Mathematics group at Sheffield Hallam University (SHU), we use the web to provide a user-friendly front-end, giving students one-click access to these materials (see Figure 1). For ease of staff use, we also offer an FTP service – this is made available to staff by means of a drive mapping through Network Neighbourhood so all teaching staff have to do is drag and drop whichever files they wish to make available. For students, the FTP site can be accessed either by a web browser or by means of an FTP client at any time and place (see for example, Figure 2). Freeware versions of all software that may be useful is provided to new undergraduates on their own individual customised CD.

Communicating with Students

Class contact time is being eroded owing to resource cut backs so it is essential that students are able to get some help when they need it. To this end, we have set up several systems, which help. Firstly, we have web-based discussion forums. These use the freeware PHP-based *Phorum* software (Phorum 2002), and although they are easy to use, our experience is that students are reluctant to utilize such systems. Despite encouragement over several years, usage remains very low, and such messages as are posted tend to be frivolous. We believe that systems, which require the *active participation* of students, are used far less than those which are inherently passive. E-mail, for example, is still the most widely-used form of staff/student electronic communication, and for that reason the second system we have implemented makes use of e-mail discussion lists. We have set up a list for each year of the course, and this works well both for staff-student communication as well as student-student communication. Staff regularly uses this as the primary mechanism for the distribution of course and unit-related messages. For student-staff communication, person-to-person e-mail is still the most successful approach.

Students are increasingly using cell phones to communicate, particularly with each other, and text messaging is becoming pervasive. We are developing an integrated SMS messaging system, which will allow staff to send text messages to students – this will be useful when contact is required urgently. (“Why have you missed your lecture?”!)

A third support system which has been implemented is the Frequently-Asked-Questions page for each unit, also referred to as the knowledge base. The idea is for staff to post articles, which

address students' most, asked questions – hopefully this will save both staff and student time if any other student subsequently needs to find the answer to the same question. This is in the embryonic stage, since staff need to post these messages and their time is limited, but the structure is in place.

Monitoring Student Work

Students on the SHU Mathematics degree programme take a unit *Mathematical Technology*, which spans both semesters of year 1. In this unit, students develop expertise in web page creation and web site design, computer programming and the use of spreadsheets, computer algebra software and hand-held devices for mathematics. Also they begin to develop their reflective skills, an essential part of the critical skill of improving one's own learning and performance. To start this process we have adopted a multi-pronged approach.

Firstly, students must begin to develop a web-based portfolio of their work. This is partly in response to the UK Quality Assurance Agency (QAA) plans (QAA 2002) for students to keep *progress files* but mainly because it is an essential part of their professional development. The intention is that during their progress on their undergraduate degree (3 or 4 years) each student will accumulate an on-line collection of their work, together with necessary text and annotation, in a conveniently accessible format. In this unit, they begin by creating an on-line resumé (which is regularly updated) and create a separate page or pages for each module they take on the course. Each student is given password-protected web space and is expected to provide a suitable means of navigating their on-line portfolio.

The advantages of this are many – for students, they are learning skills which they can immediately see will be useful, and make them more employable; for potential employers, a readily-accessible summary of the students' work is instantly available and for staff, it is easy to see exactly how much progress each student has made.

The second 'prong', intended to develop students' planning and reflective skills, is an on-line logbook. Each week the students write a few sentences about each module they are currently studying, saying what has gone well, what has not gone well, and also what plans and steps they intend to take to deal with any problems that have arisen. The advantage for the students (apart from developing reflective skills) is that they are encouraged to confront problems and explicitly commit strategies for solving them. For staff of course, it is most enlightening to see what these problems and strategies are. It is also valuable to get continuous feedback on the progress of each module as seen from the students' perspective. The is far more informative than the usual staff-student meetings each semester, since these often raise problems too late and tend to reflect the views of a small vocal minority of the student cohort. By contrast, staff reading the student logbooks see the views of each and every student continuously.

Inevitably, students will not do this each week unless there is some tangible reward. Staff provide encouragement and point out the advantages of keeping the logbook up to date, as well as generating an incentive by incorporating completion of the logbook into the assessment schedule (see Assessment later). To streamline this process, a series of web programs has been written to provide a secure framework within which the students can manage their on-line logbook. These are illustrated in Figures 3a-d. Students log in, and once authenticated can move freely through the system. All relevant student details are stored in a central database so that upon log-in the system knows which year the student is in and hence which modules should be made available.

The logbook contains a number of entries, one each week (ideally!) for each unit (see for example Figure 3a). Students can add new entries (Fig 3b), edit or delete previous entries (Fig 3c) – but only those up to seven days old, change their e-mail details, request new passwords and request that their login details be e-mailed to them.

A facility has been provided to give staff an overview of the whole set of logbooks, so it is easy to see who is up to date and who has fallen behind (Figure 3d). Each student's name is a hyperlink to their individual logbook, so staff can readily view these.

The majority of students at present have engaged with this very well – some exceptionally so. After a slow start, approximately two-thirds of the group are completing the logbooks weekly, as required, and a few stubbornly resist all attempts to get them to join the party! However the mark sheet for the unit rolls on week by week and students do not like seeing zero marks!

Assessment

Much of the learning taking place in this unit is formative. Students are learning techniques, ideas, methods of approach and reflection and organizational skills as well as knowledge. Therefore, and because students need the incentive, our approach to assessment is different from the 'traditional' approach. We aim to award a small element of assessment for each part of the work students are expected to do. Altogether 1000 points are awarded during the year. This is broken down as follows:

Web Logbook (200 marks)

- Weekly updates of the logbook (95 points). Up to 5 points are given for updating the logbook each week from week 6 to 24 (the start is delayed to accustom the student to the assessment practice)

The balance of the marks will be awarded summatively on the basis of:

- Breadth and depth of commentary (35 marks),
- Evidence of reflection, and of taking appropriate action as necessary (30 marks)
- Content, including the description of specific tasks to be carried out and the development of action plans and target-setting, in response to problems that occur (40 marks).

Web Portfolio (200 marks)

End of week 9. 60 marks awarded for the resumé, and the implementation, content and structure of the portfolio.

End of Semester 1. 70 marks awarded for the further development of the resumé, and again the implementation, content and structure of the portfolio. For the latter, more sophistication, and broader and deeper content is expected.

End of Semester 2. 70 marks awarded for the final development of the resumé, to include updates and refinements, and the completion of the portfolio with respect to level 1 modules.

Credit will be awarded for implementation of recommended guidelines for use of HTML as indicated in the handout, and for providing a suitable justification of deviations from this. All parts of the portfolio must be accessible from the main home page.

There are also three other ‘standard’ coursework assignments spread evenly through the year, which will develop mathematical skills in relation to available technology, each worth 200 marks.

Following each element of assessment, including the weekly logbook entries, marks are entered by staff into a spreadsheet. A program has been written to export the data into a customized web page, linked to the main page for this module, so that the students can always see a current view of their accumulated assessment (Figure 4). Following each major assessment point for the logbook and portfolio, students receive detailed feedback via e-mail. This is achieved by another customized computer program – staff type the comments into an ordinary text file and the program (armed with a list of students’ e-mail addresses) mails the comments to each person. This approach has the benefit of being both personal and fast, and by its very nature a copy of all comments is retained by staff for subsequent presentation to external examiners.

Conclusion

In the early days of dedicated mathematical technology Waits and Demana (1995) made a statement that "professional development blending mathematics curriculum reform with appropriate use of technology should be a top priority for educators in the next five years”. The present authors have observed that what is also needed is a change in assessment practice. But what has happened? Seven years on from that statement, technology is widely used, although in many cases not in an integrated way, but changes in assessment practice are slow to arise: the test or examination continues to dominate. If educational results are quantified only by passing tests and examinations, students become ensnared in superficial learning habits, and it is actually not possible to assess the full range of learning which we claim to encourage, including those skills valued by employers (Davis 1991).

In this paper we have addressed some of these issues. To mark a module out of 100 is arbitrary, and the concept of having 1000 marks to give enables a whole range of skills to be assessed. More importantly, in the assessment-driven, strategic learning environment in which we live this gives us more carrots to dangle in front of our students. Human nature and student economics being what they are, most students need to be pressed to act or react, and do so if tempted or pressured by credit. However this absorbs more staff effort, but minimising the impact of that is one of the tangible outcomes we have achieved using the Web.

The topic of assessment is something that many of us regard with irritation rather than interest, but we have found it does raise more heated discussion than many other topics, because of its crucial importance in the learning process. We have reported on an attempt to broaden assessment style to embrace skills that are necessary and demanded of students by future employers. Normal examination type of assessment cannot do this. The examination still has a role, but is not sufficient by itself, and the nature of the assessment must remain under review to make sure that it addresses the outcomes of learning and the skills for the future. In following through the work on this module the students have on the web their work, evidence of planning, reflection and improving their essential skills and performance, evidence of a multitude of IT skills, and a catalogue of feedback and marks!

In closing then, we say that technology is not a “threat to every university”(Daily Telegraph, 1999), but in the current example provides a significant enhancement of our students’ experience by giving an opportunity to address and assess the full range of valuable skills.

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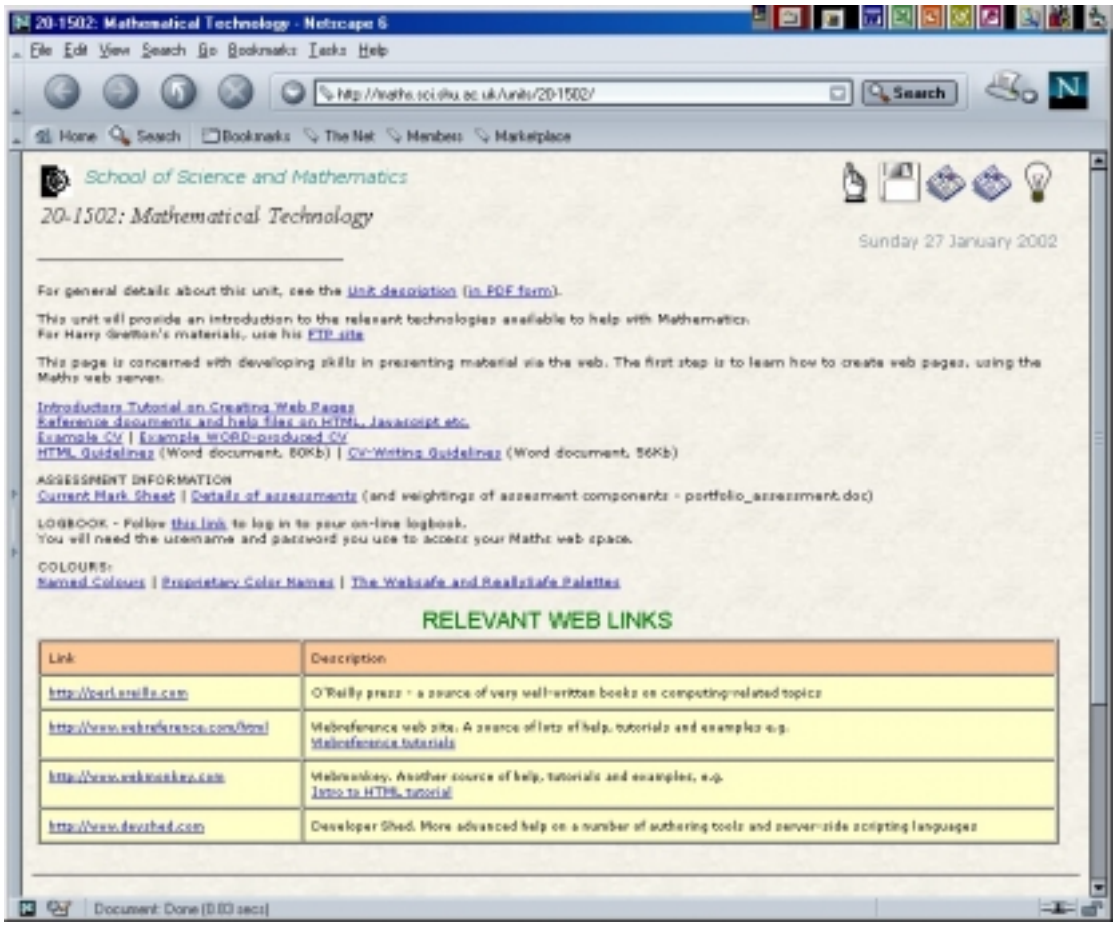


Figure 1 : The *Mathematical Technology* home page

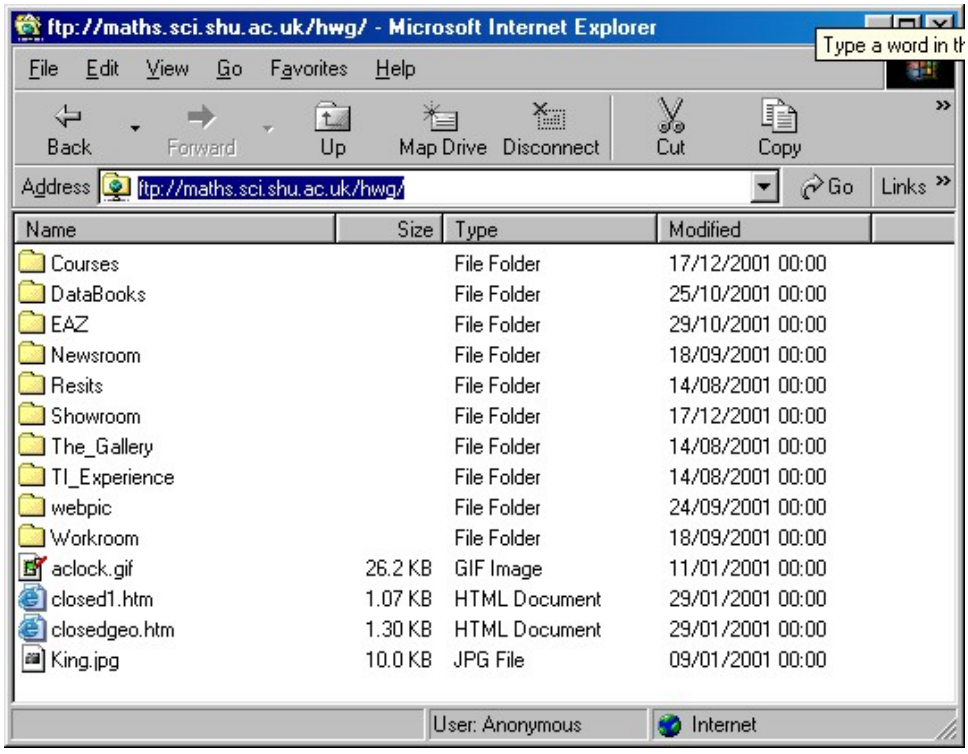


Figure 2: An example of the SHUMaths FTP site

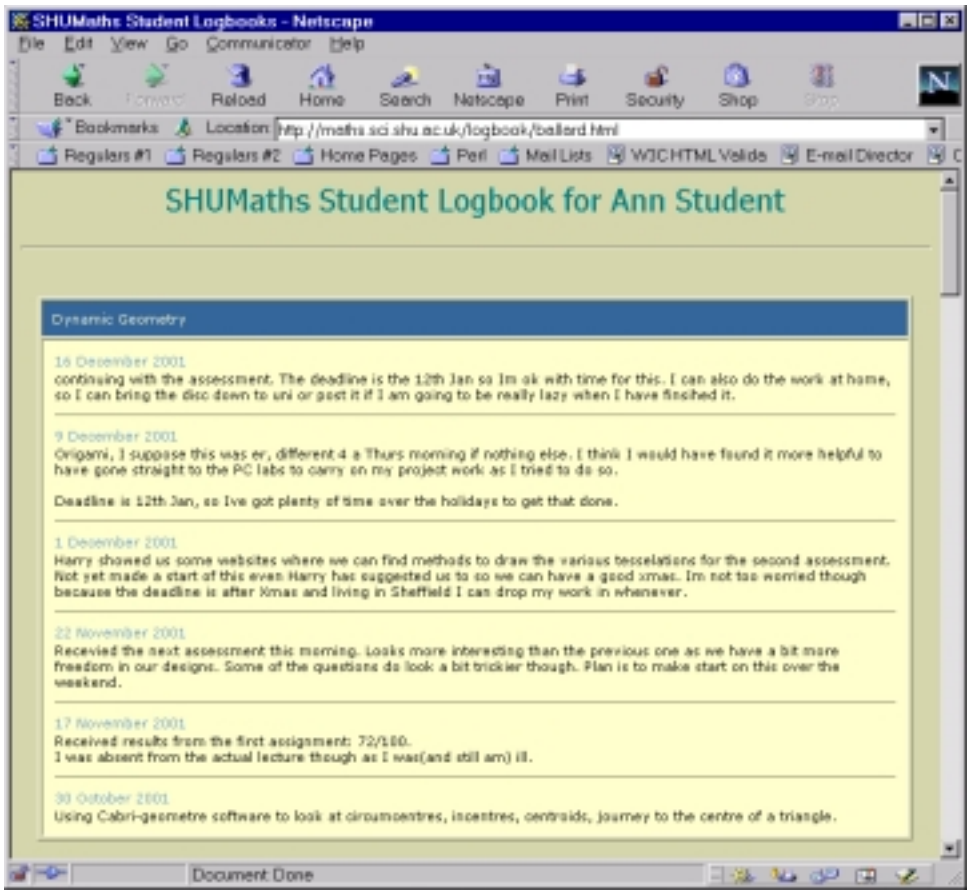


Figure 3a: An example of part of a student on-line LogBook

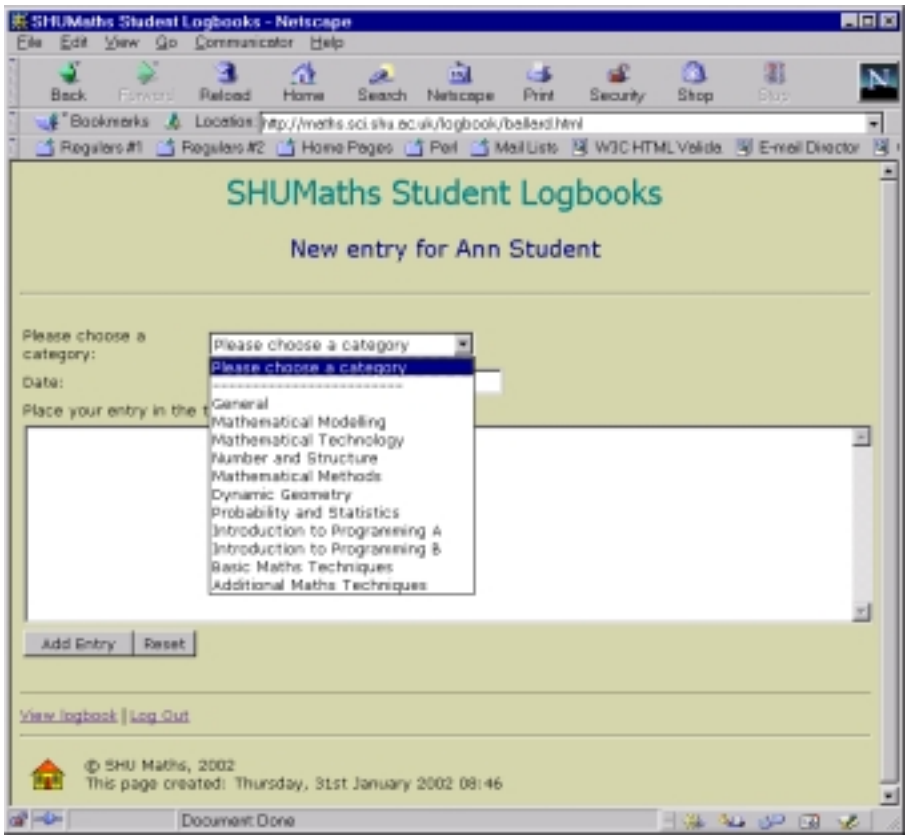


Figure 3b: The form used by students to add a new entry to their logbook

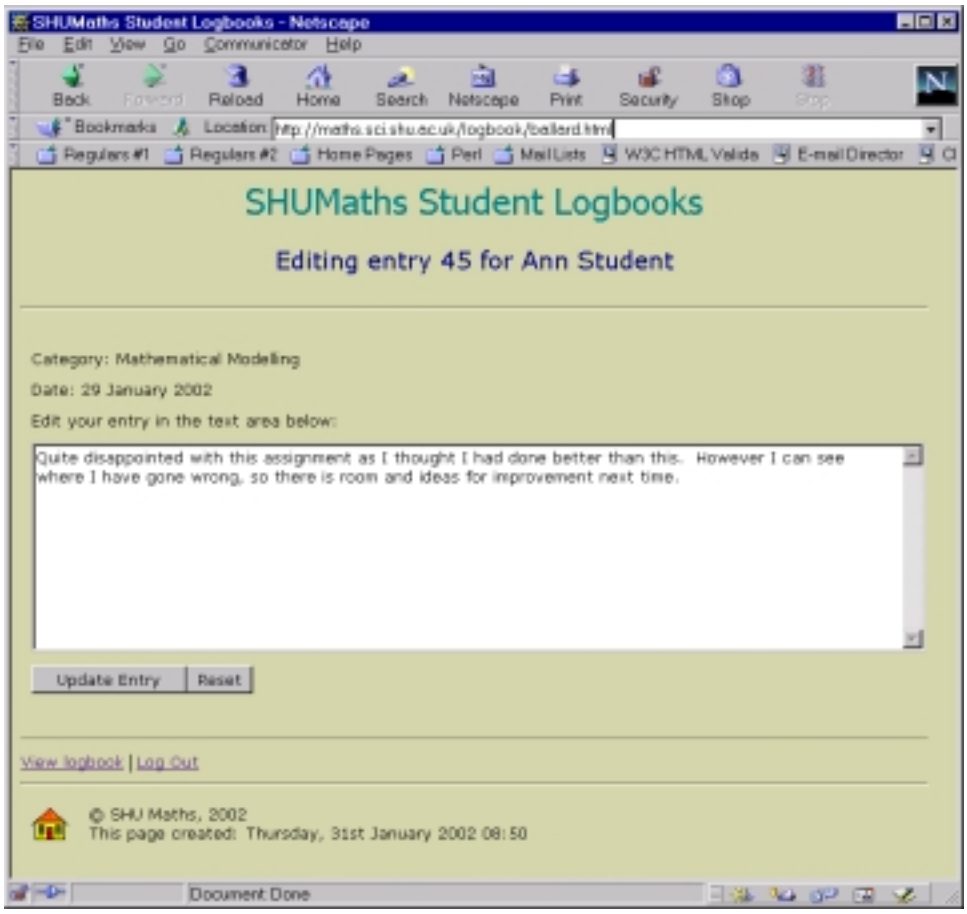


Figure 3c: The form used by students to edit an entry in their logbook

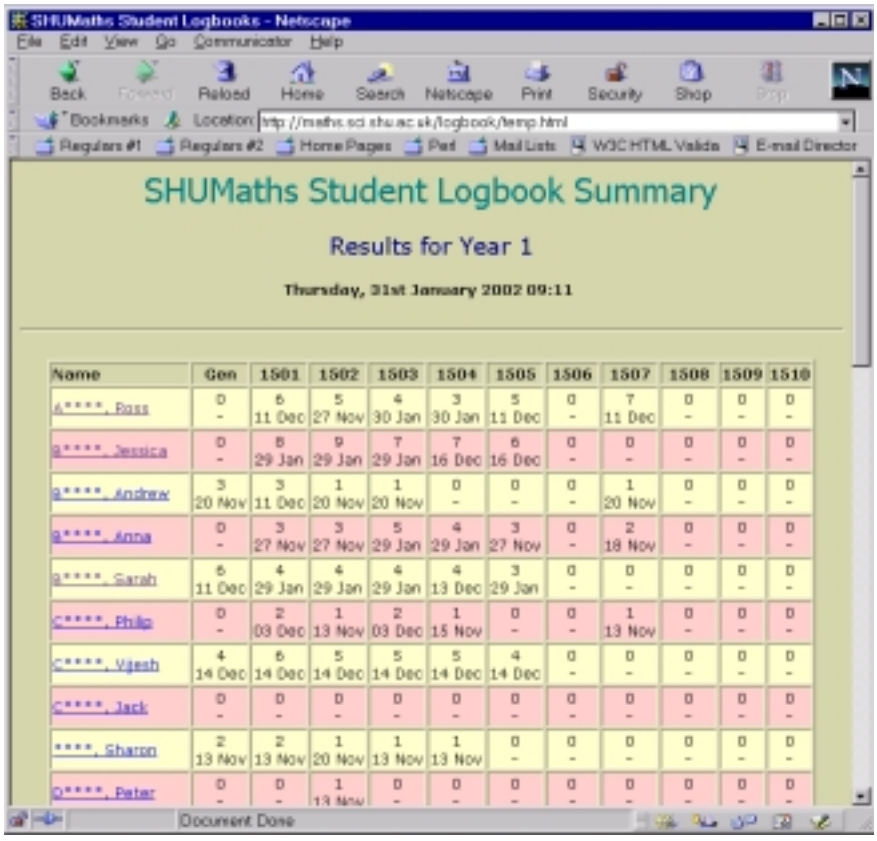
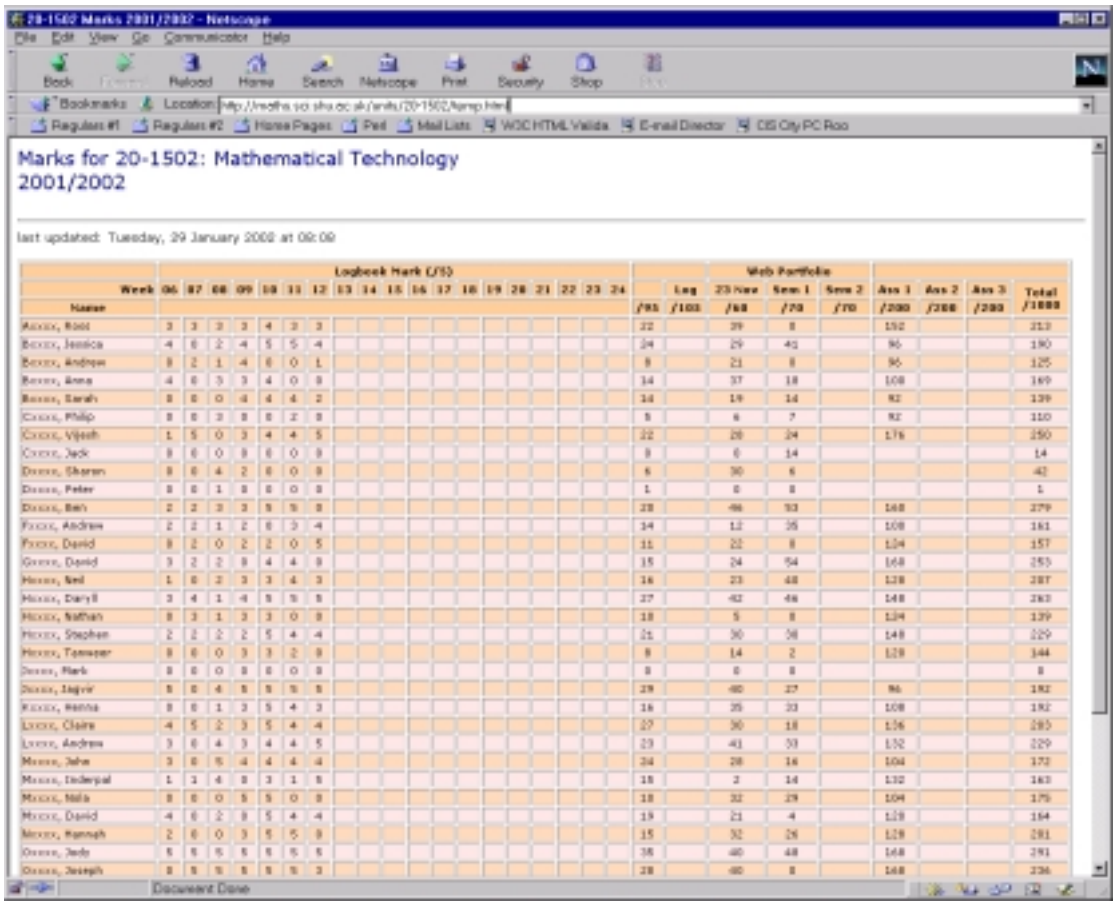


Figure 3d: The staff summary page



Marks for 20-1502: Mathematical Technology
2001/2002

last updated: Tuesday, 29 January 2002 at 09:09

	Logbook Mark (/15)																					Web Portfolio							
Week	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		Log	23 Nov	Sem 1	Sem 2	Ass 1	Ass 2	Ass 3	Total
Name																				/95	/100	/60	/70	/70	/200	/200	/200	/1000
Abbott, Rosi	3	3	3	3	4	3	3													22		39	8		152			213
Bacon, Jessica	-4	6	2	-4	5	5	-4													24		29	41		96			190
Baxter, Andrew	8	2	1	-4	6	0	1													8		21	8		96			125
Baxter, Anna	-4	6	5	3	4	0	8													14		37	18		108			169
Baxter, Sarah	8	6	0	-4	4	4	2													14		19	14		92			139
Cable, Philip	8	6	3	8	6	2	8													5		6	7		92			110
Cable, Vijesh	1	5	0	3	4	4	5													22		20	24		176			250
Cave, Jack	8	6	0	8	6	0	8													8		6	14					14
Deere, Sharon	8	6	4	2	6	0	8													6		30	6					42
Deere, Peter	8	6	1	8	6	0	8													1		6	8					1
Dixon, Ben	2	2	3	3	5	5	8													28		46	53		168			279
Fiske, Andrew	2	2	1	2	6	3	-4													14		12	35		108			181
Fiske, David	8	2	0	2	2	0	5													11		22	8		124			157
Green, David	3	2	2	8	4	4	8													15		24	54		168			253
Hesse, Neil	1	6	2	3	3	4	3													16		23	48		128			287
Hesse, Daryll	3	4	1	-4	5	5	5													27		42	46		148			283
Hesse, Nathan	8	3	1	3	3	0	8													18		5	8		124			139
Hesse, Stephen	2	2	2	2	5	4	-4													21		30	38		148			229
Hesse, Tanveer	8	6	0	3	3	2	8													8		14	2		128			144
Dixon, Mark	8	6	0	8	6	0	8													8		6	8					8
Dixon, Jagvir	5	6	4	5	5	5	5													29		40	27		96			192
Fiske, Hanna	8	6	1	3	5	4	3													16		35	33		108			192
Lyon, Claire	-4	5	2	3	5	4	-4													27		30	18		136			285
Lyon, Andrew	3	6	4	3	4	4	5													23		41	53		132			229
Mann, John	3	6	5	-4	4	4	-4													24		28	16		104			172
Mann, Inderpal	1	1	4	8	3	1	5													18		2	14		132			163
Mann, Nila	8	6	0	5	5	0	8													18		32	29		104			179
Mann, David	-4	6	2	8	5	4	-4													19		21	4		128			164
Mann, Hannah	2	6	0	3	5	5	8													15		32	26		128			281
Owen, Jody	5	5	5	5	5	5	5													35		40	48		168			291
Owen, Joseph	8	5	5	8	5	5	3													28		40	8		168			236

Figure 4: The marks sheet as seen on the web