ASSESSING MATHSKILLS USING THE WEB: 100 MARKS ARE NOT ENOUGH!

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"*You can lead a horse to water, but you can't make it drink.*"
- Circa 12th century adage included in John Heywood's proverb collection of 1546.

Introduction

Only recently has technology been able to provide comfortable and accessible environments to help students learn interesting and essential mathematics for present day use. However, it is important how students behave in those environments. Unfortunately many, even most, current students behave mainly strategically within the system in deciding how they allocate their valuable time resource. This means that many react only to formally assessed work which contributes to their assessment grade. As tutors we would of course say that this is a less than ideal attitude to learning, but it is pervading many educational establishments, who are themselves under pressure to be demonstrable "centres of excellence" and therefore have to react to assessment!

Other factors are also relevant here. For instance there are statements from university authorities and others saying that we over-assess our students: these statements may be driven by economic rather than educational reasoning. There is also a feeling that, given the wider range of skills which we might now want our students to have, the traditional examination by itself (while easier although not foolproof to verify, and arguably the most time-efficient) is not an adequate assessment instrument.

This paper describes some of the practices that we have adopted in Mathematics at Sheffield Hallam University, in the UK, to try to teach a diverse range of modern mathematical skills in a technological context, aiming to make students think about their learning, and to exploit their in-built strategic learning approach to result in desirable deeper learning. We try to balance the pressures through constructive use of technology and the web, and are developing an online portfolio approach to assessment which spreads over a wide range of activities, for which "100 marks are not enough".

What skills for mathematicians?

The students looked at here are in the first year of a UK undergraduate mathematics degree, and they study courses in Mathematical Modelling (MM) and Mathematical Technology (MT). Students on both these courses carry out critical study in these areas and develop the full range of skills, both mathematical and general, in parallel. Student engagement in the work is steered by the use of an electronic web-based planning and progress file in which they can also reflect on their learning, such reflection being an important part of improving their skills. This online progress file is regularly and frequently monitored as part of course assessment, providing a small proportion of marks, but a high degree of feedback for both student and all course assessors.

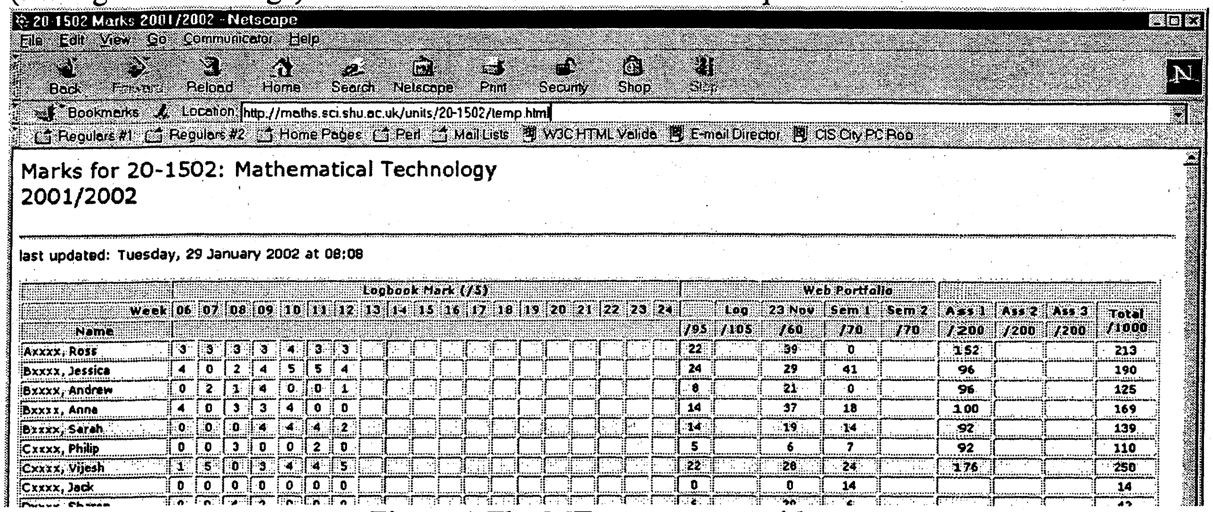
The thinking here is that there is a set of traditional *mathematical* skills, which we need not list here, which we would expect students of mathematics to acquire. However, the content of this list is challenged not only by technology but also the changing world. The use of mathematics and technology in society has an influence (Gretton and Challis(2000), Challis and Gretton (1997), Challis and Gretton (2002)). Furthermore as access to university level study widens, the needs of employers are also a significant influence, particularly the stated importance of the so-called key skills (Society for Industrial and Applied Mathematics (2001)), which include Communication; Improving your own learning and performance; Using information technology; Problem-solving; Application of number; and Working with others. For instance, since mathematics is essentially a communication language, it is critical that anyone with knowledge can recognize the audience with whom they are communicating. Without this last skill the most knowledgeable practitioner will not succeed. If we claim that our graduates have these skills then we must be able to justify that claim through our assessment practices.

Thus, as well as the mathematical content of the MM course there are these other skills to assess and this is made explicit in this quote from the formal course document: *"Skills work will include input on aspects of report writing including written English and referencing, information retrieval, curriculum vitae, group working, time management, reflection and action planning."* To allow credit to be allocated to this range of activity, there is therefore a need for more than 100 marks!

Assessment of skills

Our practice in assessing this range of essential skills and knowledge had to be thought out and presented clearly. A previous paper discussed ensuring that assessment practice fits the learning outcomes (Challis and Gretton (1999)). The student must be engaged, and convinced of the usefulness of the assessment scheme. Some previously high achievers, those who had "won the game" with the traditional examination type of assessment prevalent in mathematics, initially query the relevance of, for example, communication skills in a mathematics degree. All must adjust to a regime in which marks are given for all tasks set. This much more interactive approach to assessing raises the issue of keeping in touch with students. This was addressed in a previous paper (Waldock et al (2002)) where web, e-mail and cellular phones were all utilized!

In the MT course we use a regularly updated assessment grid (Figure 1). We assess the students' web skills, programming skills, and mathematical technology use, as well as providing and crediting the diary mechanism reflecting on and evaluating their own learning on a week by week basis, with email feedback. The MT course also provides (amongst other things) an archive area for each student to place their work on the web.



Marks for 20-1502: Mathematical Technology 2001/2002

last updated: Tuesday, 29 January 2002 at 08:08

	Logbook Mark (/5)																				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	/105	/60	/70	/70	/200	/200	/200	/1000
Axxxx, Ross	3	3	3	3	4	3	3													22		39	0		152			213
Bxxxx, Jessica	4	0	2	4	5	5	4													24		29	41		96			190
Bxxxx, Andrew	0	2	1	4	0	0	1													8		21	0		96			125
Bxxxx, Anna	4	0	3	3	4	0	0													14		37	18		100			169
Bxxxx, Sarah	0	0	0	4	4	4	2													14		19	14		92			139
Cxxxx, Philip	0	0	3	0	0	2	0													5		6	7		92			110
Cxxxx, Vijesh	1	5	0	3	4	4	5													22		28	24		176			250
Cxxxx, Jack	0	0	0	0	0	0	0													0		0	14					14

Figure 1 The MT assessment grid

In the MM course the students also develop general skills integrated with more specific modelling work. For instance the course document states: *"You will compile a portfolio of your work on this unit in two parts, by which your performance will be assessed: The first part will contain evidence of mathematical and modelling work performed in the course of the unit. The second part will comprise your portfolio of evidence concerning your transferable skills development."*

Figure 2 shows a part of the assessment grid used. The weighting of marks given for each of the assessment elements can be adjusted to reflect how much they are valued.

20-1501: Mathematical Modelling Marks Grid as of 12/06/02

		Modelling								Total	Skills										Total Re
		lhr	3hr	Vectors	Mats+SE	L P	Lakes	Popln	Cisterns		oral	report	poster	Retrieve	tech	group	cv	plan +	manage time	All	
		50	50	50	150	100	150	100	150		20	20	20	20	20	20	20	20	20	20	
Maths	Name																				
***	***	29	36	35	84	83	123	78		59	13	13	11	18	18	20	18	18	18	18	83
***	***	26	28	38	130	69	95	61		56	13	13	11	12	12	20	14	8	8	12	62
***	***	39	31	41	66	81	123	65	93	67	13	13	11	12	12	20	13	8	8	12	61
***	***	32			95	78	99		62	46	13	6	11	8	10	20	10	4	4	8	47
***	***	37	47	45	89	86		75	129	64	13	13	11	13	14	20	14	8	8	14	64
***	***	26		16	61	50	95	47		37	10	14	12	12	12	20	13	6	6	8	57
***	***	27			59	82	96			33	10	14	12	12	12	20	10	4	4	8	53

Figure 2 The MM marks grid

It is apparent then that both courses are driven by the assessment. The MM and MT courses are complementary. They run in parallel and both work on developing transferable skills. For evidence of achievement of learning, particularly in relation to skills, they can both draw not only on work within each unit, but from other areas of a student's work too.

Discussion

What we are doing here is using an approach to assessment which is unusual in mathematics, although perhaps less so in the arts and humanities. Degrees in diverse disciplines make widely different demands. Mathematics has been predominantly assessed by examination whereas other areas have been more coursework based, with correspondingly better perceived attainment levels. What we report here to some extent redresses this balance. This is timely because the world is developing, and the traditional examination is not a valid way of assessing the full range of skills, both those required by technology, and the more general skills valued by employers. Once we break out of the 100 marks examination mindset then we can assess quite complicated skill regimes that are fundamental to the future success of our graduates. We have found it useful to subdivide the credit into 1000 "marks" as that gives flexibility for weighting the perceived relative importance of all the skills and knowledge needed by our student.

However, it is worth saying that without the commitment of both students and all teaching staff to this process, it is difficult to make this change. In this respect it is like the early days of embedding graphical calculators, where some antagonistic individuals can undermine innovation. Staff and students are engaged by rational argument concerning the facts about graduate destinations and needs. Students also respond well when they see a few zeroes in their (transparent) progress file mark grid!

Finally to give an indication of how students respond, here are a few quotes from the students themselves on their learning process – some on planning and some reflecting on their plans (for which they gain marks!)

"I feel I had to chop and change my timetable quite a bit before finally completing the assessment. What I failed to distinguish is that each week is very "chock-a-block" or busy for me, and I think I simply got head over heels and made unrealistic targets that were never going to be reached"
"Next time I make a plan for an assessment I believe that I will create it exactly as I expect to do it and not how I would like to do it, at least that way I will be being honest."
"All in all, I think this a pretty good piece of work. Not the best things I have done all year, but definitely not the worst"
"If I were to make any changes for the future I would leave catch up weeks in the middle of the plan, just in case; and I would also try to guess better how much work is involved in each item."

In general, the evidence arising from this approach which encourages planning, reflection and full and current feedback, seems to indicate that the students are attaining a more mature, deeper and engaging attitude to the process of learning, a skill as valuable as any arising from current knowledge.

Conclusion

Students have a choice over which parts of a course to engage fully with. By what we have described here, we hope to encourage an attitude of reflective, continuous engagement, appropriate for a technology-intensive and changing world. At the end of our courses students have an "Arts type" portfolio covering all their courses, and available on the web, providing evidence of all their work and expertise both mathematical and general. This provides a much fuller picture of their abilities than would just final marks. Is this kind of picture something that employers considering employing our graduates would welcome?

Professor Peter Jones said at a recent conference "We must not educate students for our past but for their future" (Jones, 2000). The reflective approach to learning encouraged here is a constructive response to the feelings behind that comment, where in a rapidly changing world it is important to foster and develop the attitude that learning is never finished!

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