The More Maths Grads HE Curriculum Team – Neil Challis, Mike Robinson and Mike Thomlinson

"Employability" skills in mathematical courses

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A degree in a mathematical subject is special not only because it involves studying mathematical sciences, but also because it develops certain valuable skills, such as logical and abstract thinking, and an analytical approach to problem solving. But what other more generic skills might, say, future employers or colleagues expect or hope for in our graduates?

As we work on the More Maths Grads HE curriculum theme, one task we are given is to "ensure that the requirements of employers are considered". Indeed the upcoming STEM project has the related aim of "more and more employable graduates". This is an issue which is not going away, and it raises questions about what a university education is for.

We choose in this present instance to interpret this aspect of our task as to "ensure that the employability of our graduates is considered". We have gathered a variety of information through questionnaire, individual and group interviews, from both staff and students at four diverse institutions (including our own), and we have exploited other sources, about the issue of skills, and we report below upon some of what we are finding, in the hope of provoking discussion and debate.

Which skills and why?

First let us ask whether our data supports why we should consider the matter of graduate employability? Our questionnaire was completed by 223 mathematical sciences students across diverse universities during their first year induction week. In answering a question concerning why they chose to apply to university, 93% rated the statement "I need a degree to get a good job" as 'very' or 'quite important', with a fairly uniform response across the institutions. Our students may (or in some cases may not!) love mathematics, but clearly they see a degree as providing them with an advantage when it comes to getting well-paid work.

The importance of employability is confirmed more widely when we look at graduate destinations, for instance as presented on the Prospects website [3]. 61% of 2007 Mathematics graduates who provided information were in employment or combining employment with study in early 2008. Incidentally, of those in employment, 40% were working in business and finance, with only 2.1% in engineering, or scientific research, analysis and development. Many of the remainder were in generic roles under headings such as managerial, clerical and secretarial jobs. Where do our preoccupations, whether about research, or about what topics and content to include in our curricula, stand in the light of these data?

As for the national context and implications of this, a good overview is to be found in Stephen Hibberd and Michael Grove's current *MSOR Connections* article [2]. Employers have repeatedly said that they not only value our graduates' specialist skills, but would also look for development of a range of generic skills, what might be called employability skills, including amongst others written and oral communication, team working, and IT skills.

Indeed the subject benchmark statement for mathematics, statistics and operational research [4] in paragraph 3.27 acknowledges the importance of developing these skills, although it does also acknowledge that some programmes will develop them more than others. In any case though, given the benchmark statement, there is recognition that generic skills development is a concern to be addressed in university degrees: it cannot be left only to schools or to employers themselves, as we would surely like to think that our graduates are literate and articulate. Not all feel comfortable with this:

"it's sort of sad that we have to make up for all education in society's ills. We are not allowed to drop standards of course…"

In the semi-structured interviews we conducted – a total of 35 with a variety of staff and students from the four institutions – the issue of generic skills did not feature consistently across the institutions, and this fact is worthy of mention. It may be that more would have been said if we had specifically guided the conversations that way, but in the end the responses varied from one institution to another, with considerably more emphasis placed upon the issue in the post-92 than in the pre-92 institutions.

What do students say about skills?

We asked the 223 new first year students who took part in our questionnaire about which skills they expected to develop during their course, and which they expected to be important to them in their future life, whether in work or elsewhere. A selection of relevant results appears in Table 1.

Skill area	Expected to develop during course a lot or quite a lot	Expected to be very or quite important in future life
Logical thinking	98.2%	99%
Analytical approaches to working	96%	98%
Applying mathematics to real world problems	93%	95%
Thinking in abstract ways	91%	81%
Written communication	57%	86%
Oral communication	67%	92%
Making presentations	57%	82%

Table 1 – Selection relevant results from first year student questionnaire

Clearly even though at this early stage students are recognising the potential importance of generic skills, it is not surprising that expectations match better for skills which are recognisably mathematical, than for more general skills. In many cases students do not expect skills to feature at all:

"I didn't expect to have something like professional academic skills either - that's not really maths at all."

In fact it is not uncommon for students to object:

"I took [Maths] obviously 'cos I enjoyed it at school and I don't really like dealing with words";

although they sometimes appreciate after the event being forced to address their skills. One tutor reports of a student who complained about a report writing exercise:

"he'd learned an enormous amount and it was a very good bit of assessment in his opinion."

What do staff say about skills?

There are interesting developments and thinking taking place in our various institutions both with mathematical and generic skills development. In all cases there is of course an emphasis on developing mathematical skills. There is some interesting thinking going on about the idea that what a mathematics degree should really be about is skills and behaviours rather than particular content:

"… in Mathematics when people come to talk about… curriculum… they always talk about content, whereas I think in other subjects they don't, they're not so hung up on the content… they do think more about what are the skills and things that we want our students to… come away with"

"I mean what people don't really realise about a Maths degree is that… it's a skills degree and when you've got your Maths degree if you go off into the world of work… you're not saying, 'Oh look I can integrate these'… it's to do with, "Look I'm capable of thought on this level, I'm capable with this of dealing with this level of abstraction, I'm capable of using models and I'm capable of like applying my brain in a really strange way and like problem solving."

This prompts us to present a light-hearted caricature of the design of mathematics courses, with which we invite readers to take issue. We overcrowd our curriculum, as we all have pet topics which must be in so that we can feed our research programme. This is to the detriment of the majority of students who are not going to be research mathematicians, and the need to cover so much ground does not give most of our students the space to work on and develop those good mathematical behaviours and skills that we say we expect them to have upon graduation.

All this is before we turn to generic or employability skills, which we do now! In two of our institutions there is a well-

developed strategy for generic skills development, more of which below.

In the other cases it is less well developed. In a discussion about project work and writing skills and "that type of thing", one response was:

"Very important, we do almost none of that and… we should. I mean, we can't… do everything."

In another discussion:

"…you're teaching… the subject for its own sake, and for the 2nd and 3rd year courses, to support those, more than thinking 'what skills will this person need in their job in 10 years time'."

One implicit thought here is that there are choices to be made about what topics and activities we put in front of our students, and we need to be explicit about the criteria by which we are making our judgements. There is of course a balance to be struck, and a tension between on the one hand staff priorities, interests and preoccupations under pressures such as the RAE, and on the other hand student concerns and expectations with regard to being attractive to employers. In fact even for the minority of students who may become future researchers, they will have a thesis to write and papers to give, so the issue of skills is not irrelevant to them!

As an example of balance, we may think writing skills are important, but we would probably not fail a student who struggles with writing but can "do the maths". Indeed students would feel hard done by if we did! On the other hand, are we not doing the majority of our students a disservice if we do not address their wish to get good jobs, and help them to understand what being employable means, by showing that we value generic as well as mathematical skills? And how are we to show we value something if not by giving credit for it?

We must of course be realistic about what we can achieve, where other parts of the educational system have not entirely succeeded, but a variety of practice is beginning to develop now, some of which begins to address the issue of making space in the curriculum. This is discussed below.

In what ways is skills development being addressed now?

In this section, we look not only at what is happening within our reviewed institutions, but also mention some developments in the wider world of UK Mathematical Sciences.

One useful wider initiative concerns the Skills Development working group convened by Stephen Hibberd on behalf of the HEA MSOR Network. An example of activity linked to this group was a workshop on developing graduate and employability skills in mathematical sciences, reported in a current *MSOR Connections* article [2]. The workshop contained not only contextual discussion, but also reports of skills development initiatives at a range of diverse institutions, giving a range of ideas for how skills can be developed in different contexts.

Two of these case studies concern concerted initiatives at two of the four institutions, both post-92, in our current study. We will not repeat the details, which are well described in this very issue of *MSOR Connections*, but will comment that it is interesting that two institutions which may superficially appear similar have chosen different routes.

One approach, as reported by Sydney Tyrrell, involves skills modules in both first and second year which are compulsory for mathematical students, combined with a university-wide initiative labelled *Add+vantage*.

The other, Sheffield Hallam mathematics approach is reported in some of its aspects by Jeff Waldock. That report concentrates upon the online learning log which aims to encourage students continually to reflect upon their progress. The provision broadly aims to embed the development of skills throughout the curriculum at all levels, seeking opportunities to work on, develop and assess generic skills as part of mathematical modules, for instance in modelling or through a final year project. The general approach has been reported previously (e.g.[1]). Here is one interview exchange about the IT skills aspect of this:

A: "… I know our students that go out on placement, what they're really appreciated … for is their Excel skills … something quite mundane really as far as the Maths goes but, you know we've had one or two that have sort of revolutionised offices they've gone into … just with Excel"

B: "Is it because you incorporate Excel in your modules that, that they get a large working knowledge…?"

A: "Yeah, that's it really, yeah."

B: "Of Excel rather than having a course and this is how you do Excel?"

A: "Yes."

There are two points worth mentioning here. One is that in this case, curriculum time is not "lost" when skills development is integrated in mathematical modules, but it has been necessary to design and map the overall pattern of assessment to include a balanced programme of outputs such as posters, presentations and written reports as well as more traditional activities such as technical coursework and even examinations! Students develop their skills by exercising them and receiving feedback, and they receive some element of credit for this aspect of their work.

The other point concerns the mention of an industrial placement, which provides a major experience through which students inevitably develop their employability skills. There will be more of this in a future article.

Discussion

There is no consensus concerning the place of generic skills development in the HE mathematics curriculum for every course. In some courses it is a significant presence; in others it is conspicuous by its absence. Whose job is it to develop these skills? What if anything is to give way if skills development is to be included?

A glance at the widely accepted MSOR benchmark [4] shows that the job should fall at least in part to the HE community - if we claim our students have these skills then should we at least show how we know, and what contribution we have made? Not all agree. Academics are chosen for their love of and enthusiasm for their subject and there is of course more to a university education than preparation for work, notwithstanding what we have written above. Is the secret then to find ways of and opportunities for incorporating skills development in our courses which work within our own contexts and allow us to stay true to our subject?

So, is current developing practice in any way transferable? Our gleanings suggest institutional approaches to skills vary: see for instance the contrast between Coventry and Sheffield Hallam.

However it may be that, if course designers are seeking to improve the generic skills development aspect of their mathematical courses, elements of experience and ideas can usefully be passed on and modified.

Ideas and questions

If readers are thinking about enhancing the generic or employability skills element in their courses, we suggest some questions they might like to consider.

- Is it desirable to have a separate skills module, or to integrate skills development into other activities in the course, or some combination of these?
- How can skills such as writing, presenting, and working with others be developed through mathematical activities, for example through modelling or project work, or indeed through mathematical modules?
- Could a learning log have a role to play in encouraging a reflective approach?
- If skills are to be assessed, what part should that assessment play in the overall pattern of assessment?

Whether you are doing something exciting with skills development, or you are looking to improve how you deal with your students' generic skills, or indeed want to take issue with what we have said, we invite you to contact us and join in the debate.

References

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Editorial Comment

For more info and to download presentations from the "Developing Graduate & Employability Skills within a Mathematical Sciences Programme" workshop, held 23 June 2008 at the University of Nottingham, please visit: ***http://mathstore.ac.uk/index.php?pid=199***