Employability development for HE mathematics and statistics: case studies of successful practice

Edited by: ROWLETT, Peter <http://orcid.org/0000-0003-1917-7458> and WALDOCK, Jeff

network for excellence
sigma Σ
in mathematics & statistics support

Employability development
for HE mathematics and statistics

case studies of successful practice

Edited by Peter Rowlett and Jeff Waldock.

On behalf of the **sigma** Network Employability Special Interest Group:

Jeff Waldock, Sheffield Hallam University (Co-chair);
Peter Rowlett, Sheffield Hallam University (Co-chair);
Noel-Ann Bradshaw, University of Greenwich;
Jonathan Cole, Queen's University Belfast;
Dave Faulkner, University of Hertfordshire;
Laura Hooke, Loughborough University in London;
Frances Whalley, University of Hertfordshire;
Kinga Zaczek, Royal Holloway, University of London.

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Introduction

This collection of case studies arose from the work of the **sigma** Network Employability Special Interest Group. The Employability SIG was founded in 2016, alongside SIGs in Accessibility and The Needs of Statistics Support. These initiatives were developed by the **sigma** Network to address over-arching themes of interest to the mathematics and statistics support community in higher education.

The Employability SIG activity in academic year 2016/17 had aims to:

1. source or develop resource materials to help staff working with students to develop their employability, either in a support environment or for taught sessions;
2. create a guide for staff aiming to develop student employability through the curriculum;
3. gather a collection of short case studies of successful practice from across the academic spectrum relevant to **sigma**.

This booklet contains the outputs from aims 2 and 3.

For outputs from aim 1 and information about other SIGs, please check the **sigma** Network website at www.sigma-network.ac.uk.

Following this introduction is a guide for staff aiming to develop student employability through the curriculum.

Following the staff guide are a collection of 18 case studies.

The first four case studies describe initiatives to develop students' numeracy skills, for the workplace and for graduate recruitment testing.

Case studies 5-9 describe work relating to the transition to employment, including by encouraging specific career management skills and awareness of different career routes. Case study 10 offers an alternative online video method to encourage students to develop their interview skills.

Case study 11 describes a placement preparation initiative, while case study 12 discusses the assessment of placement learning.

Case study 13 discusses the wider range of graduate employability skills that can be developed through the curriculum, which sets the scene for case studies 14-18, describing initiatives to develop those skills.

We have been honoured to be asked to be inaugural chairs of the **sigma** Network Employability SIG, and have enjoyed compiling this collection. We hope it proves useful.

PR & JW, July 2017

Employability in the HE mathematics curriculum

Jeff Waldock, Sheffield Hallam University.

Background

All stakeholders in Higher Education are increasingly aware of the importance attached to the additional skills students should be gaining at university, over and above their course-specific skills. Students are concerned that courses will provide them with the full range of skills necessary to successfully gain graduate level employment. It is clear from university open days that prospective applicants are very aware of the range of measures by which they can judge the performance both of universities and of individual programmes, such as the National Student Survey (NSS), the Destination for Leavers from Higher Education survey of graduate employment (DLHE), the various league tables, as published for example by the Guardian and the Times, and the Teaching Excellence Framework (TEF).

> Embedding employability into the core of higher education will continue to be a key priority of Government, universities and colleges, and employers. This will bring significant private and public benefit, demonstrating higher education's broader role in contributing to economic growth as well as its vital role in social and cultural development.
> (HEFCE, 2011; cited by Cole and Tibby, 2013, p.5)

> It is essential that students are engaged with employability to foster and develop a culture of progression and life-long learning. Long-term success will depend on students' ability to recognise their own personal, academic and career development achievements and needs throughout their lives. HEIs are in a position to set them on the right path to begin this journey.
> (Cole and Tibby, 2013; p. 5)

Meaningful metrics and indicators around how institutions are embedding aspects of employability should be considered and used as part of a narrative, supported by relevant figures, to provide a clear account of their commitment to improving employability (Norton, 2016; p. 3). We could, for example, measure the percentage of students:

- that have an opportunity to undertake a university-supported work placement;
- that can access a range of other work-related learning opportunities, for example internships, modelling simulations, projects and case studies;
- accessing career guidance and advice at level four, five, six and beyond;
- who are engaged in institutional employability-related awards or institutionally endorsed extra and co-curricular activities (Norton, 2016; p. 3).

Norton (2016) says "clearly this list is not exhaustive but is a catalyst for discussion as to what areas should be considered within a broader view of measuring input and output activities, as well as access of opportunity for improving employability" (p. 3).

> A bespoke evidenced narrative offers an avenue for HE providers to clearly inform their TEF submission. This not only provides an opportunity for an improved offering for students, but will highlight to those assessing the TEF submission the direction of travel by the provider. This is essential in order to approach the intricacies of embedding employability throughout learning and teaching practices.
> (Norton, 2016; p. 3)

> The White Paper talks about involving stakeholders from the outset. The TEF consultation refers to stakeholders being part of assessment panels. Are we

> working towards those shared goals? Of course, our students develop their knowledge by studying. Institutions have a careers and employability service. We provide opportunities for students to gain work experience in industry. We support students in developing skills such as communication and teamwork. But what else? How do all these areas come together and link up? Think about how staff are engaged in this process; through the language, through the discourse, broadening this out to get all staff engaged so that they recognise the importance of their contribution.
> (Norton, 2016; p.4)

> Students can reflect on their skills at the start and end of their courses and assess themselves, providing a metric of learning gain. More importantly though, the single biggest difference we can make to students' employability is to raise their awareness of it, increase their understanding of what it is made of and let them see how well their studies can support their development of skills as well as knowledge.
> (Rich, 2015)

Employability is (adapted from Cole and Tibby, 2013; p. 5)**:**

- a lifelong process;
- applicable to all students whatever their situation, course or mode of study;
- a complex process involving a number of areas that interlink;
- about supporting students to develop a range of knowledge, skills, behaviours, attributes and attitudes which will enable them to be successful not just in employment but in life;
- a university-wide responsibility;
- about making key skill development explicit to students to enhance self-awareness;
- developing self-confidence through an awareness of their own developing skill set.

Employability is not (adapted from Cole and Tibby, 2013; p. 6)**:**

- about replacing academic rigour and standards;
- necessarily about adding modules into the curriculum;
- just about preparing students for employment;
- the sole responsibility of the 'careers' department;
- something that can be quantified by any single measure (the DLHE survey is a measure of employment, not employability).

The idea that the university experience should be about more than the degree itself is not a new one, but it is still one that few universities – especially within academic departments – promote in a meaningful way. At a time when graduates can expect to leave university with debts of upwards of £40,000, applicants are looking closely at what each course and institution offers – over and above the degree programme itself. High tuition fees lead to equally high student expectations, both of the qualification and the university experience. In challenging economic times these expectations are likely to also focus on graduate job prospects. As a result of this, and pressure from Government, business and industry, many Higher Education institutions are adopting a renewed focus on the student experience and in engaging students as partners in learning. A common response of many HEIs has been to promote extracurricular activities, bursaries, awards and careers support; relatively little has changed within the curriculum.

Curricular approaches

A key stage in the design of any programme of study is to identify the skills its graduates should possess. In some discipline areas there is a body of core knowledge or content prescribed by the requirement for professional body accreditation, however all programmes should recognise the need for graduates to possess certain generic capabilities. Furthermore, it is often the generic skills that have the greatest influence on employability.

The most important of these skills are:

- self-confidence, especially in tackling new challenges;
- self-awareness – knowing what you are good at, and being able to articulate and evidence this;
- problem-solving skills – knowing how to think creatively and apply existing knowledge and skills in new situations;
- the ability to communicate effectively and appropriately to different audiences;
- the ability to work with successfully with others – having inter-personal skills.

How can a course curriculum encourage the development of skills such as these without losing core content?

Appropriate learning, teaching and assessment strategies can be chosen so that students gain generic and subject specific skills at the same time.

Being self-aware, recognising and being able to articulate and evidence skills, can be developed through **reflective practice**. Processes to support this – such as personal development planning – can also lead to greater levels of self-confidence since students will be encouraged to reflect on their progress and look objectively at their developing abilities. A departmental approach that treats students as partners in learning, explaining the rationale for the curricular structure and how tasks have been designed to help them develop a variety of skills throughout their course, is more likely to lead to greater levels of engagement, satisfaction and, ultimately, achievement.

Most mathematics courses are content heavy, with a prime focus on the mastery of advanced concepts and delivering research-ready graduates. However, the majority of mathematics graduates enter employment in areas such as the financial sector or in education, and it seems appropriate that at least some degree courses should be aimed at preparing them for that workplace.

Mathematical modelling and project work provide vehicles for students to apply skills in new situations, think creatively and work in teams. Assessment tasks include writing and presenting – in various forms – to help students gain confidence incrementally throughout the course. Success at practical application of mathematics leads to greater levels of confidence and a greater willingness to tackle new problems.

Graduates from such courses will be familiar with dealing with open ended problems, communicating the results in a variety of ways – for example orally, in writing and through poster presentations. They will be adept at working in teams, proficient with technology, confident in using their mathematical knowledge in new ways and (if they chose to undertake a placement) able to evidence relevant work experience in their CV.

Higher levels of student satisfaction and achievement can be achieved by making real the rhetoric about making students **partners in learning**, and providing a student-oriented supportive learning environment within which to study. This applies to employability and academic achievement alike – both areas benefit equally. If students engage in regular reflection and action planning (by whatever means) they gradually learn to recognise what skills they are gaining and where and how they are gaining them, and to identify and tackle problems that

occur. At the end of each academic year, students can gain a great deal of confidence by reviewing their progress, recognising how far they have come and how much they have achieved. It seems to be human nature to value skills yet to be acquired over those already acquired, and this review helps students recognise the value of what they have achieved already and provide added confidence that they can continue to achieve more in the future.

Student support is a key element of an academic programme, but it need not always come from academic staff. Evidently, we want students to learn to operate independently, developing confidence that they can work problems through for themselves. One successful approach is to form new entrants into small groups focussed on a small curricular project, facilitated by a more experienced student – a **Peer Assisted Learning** leader. PAL leaders will be volunteers, willing to give time and commitment in return for valuable CV-enhancing leadership and people-management skills. The first year students within each PAL group quickly develop a strong bond and although the scheme may only last for one semester, tend to remain together throughout the course. It becomes a friendship group, representing a powerful source of peer support which often outlasts the course itself.

These student groups naturally work together outside class times on coursework tasks, doing so wherever possible in close proximity to staff offices, so that they can seek help if necessary. Recognising that there are times when staff do need to be available to provide support, and mindful of our aim to develop a meaningful staff-student shared community of learning, a suitably-designed physical space within the institution can better facilitate this activity.

Approaches taken to embedding graduate skill development

A significant barrier is the practical difficulty of finding space for graduate skill development in a crowded curriculum. As stated earlier, this problem can be addressed – at least in part – through different approaches toward learning, teaching and assessment that allow skill development to take place alongside the development of discipline-specific skills, and by encouraging students to take part in extra-curricular activities. Central to this is the need to increase student awareness of the wider purpose of each activity in developing their skills, and the value of doing so. In this regard, it is very important that students are able to recognise the part each activity plays in helping them towards the attributes expected of a graduate from their course. If so, they will be better able to see the benefit of the curricular strategies adopted, and hence better able to articulate their skill development when required.

The requirement by HEFCE to publish employability statements forced universities to clearly articulate exactly what it is they are providing students with in this regard. One result of this is the need to highlight the ways in which individual courses help students both to develop employability skills, and to recognise their importance.

One possible approach is to categorise these skills, identifying the activities within the curriculum that are involved. Course planners can then map these activities, showing progressive skill development across each level, and students can see how each activity is designed to build their skill set towards that expected of a graduate. It is often the case that courses already include such activities, building employability skills alongside subject-specific technical skills, but without emphasising the fact. A light touch modification of a course, pulling together a ‘skills map’ to raise awareness of this may prove effective in itself. A fuller map, such as the one illustrated in Appendices 2 and 3, may be used to identify a thread of employability activities throughout a course.

Course Approval or re-Approval

When approving new courses (or reapproving existing ones) it is very helpful – both for the approval panel members, and later on for students – if the employability skills developed through the course are highlighted in the following ways.

- Providing a section similar to Appendix 1, in which a clear statement is made about how each is addressed within the programme.
- Providing a skills mapping table that makes clear where in the curriculum the skills are developed, and through which activities. An example is provided in Appendix 2, detailing specific modules that are involved at each level. A second table, such as illustrated in Appendix 3, identifies the employability thread within the course. This makes it clear to all stakeholders that skill development is important, and helps everyone recognise where and how it is happening. Note that this may simply involve drawing out activities that are already in place, but may in some cases require learning, teaching and assessment development.
- Highlighting all the various ways in which work-based and work-related learning (WBL and WRL) can happen. A typology of WBL – not necessarily exhaustive – has been included for reference in Appendix 4.

If each of these areas is clearly addressed in the documentation, the course approval process – at least in respect of employability – should run smoothly!

Summary of steps towards embedding employability in the curriculum.

Action in three key areas is important:

1. **Learning, Teaching and Assessment.**

   Incorporate elements of experiential learning – for example in developing 'real world' authentic mathematical modelling exercises. Reward the development of 'employability' skills through assessment, giving it (to some extent at least) parity of esteem with the development of more technical skills.

2. **Authentic Work Experience**

   This will contextualise learning, especially when integrated into course curricula. Explore the possibility of work-based learning, in particular the possibility of a sandwich placement year. Build in elements of reflection and articulation on learning.

3. **Institutional Culture**

   If the institutional culture supports the development of employability this will help streamline the process of embedding it in the curriculum. Ideally employability enhancement will be a 'core value' and organisational practice and structures will be in place to provide practical support. Perhaps to be emphasised is the fact that this will provide added value over the degree content itself, leading to improved graduate employment rates, more satisfied students, improving course reputation and student recruitment – all very useful for improving the metrics by which institutions and courses are judged.

Elements for success

When designing, or modifying, a curriculum to support employability, remember:

- small changes can have a big impact;
- to make the tacit explicit – there may already be plenty happening;
- to use learning, teaching and assessment practice – particularly assessment – to develop employability skills alongside technical skills;

- to engage students as partners, explaining rationale and the big picture – highlight skill development in all activities;
- to engage students in reflection and action planning – developing self-awareness;
- to incorporate work experience, and realistic work-related learning;
- to secure institutional support;
- to reinforce and re-emphasise skill developments regularly.

References

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Appendix 1 - A classification of 'Graduate' Skills

1. **Work-based learning and/or work-related learning.**

   This can include everything from work experience to year-long work placements, as well as simulated work experience. See Appendix 4 for a typology of modes of WBL/WRL.

2. **Reflection and action-planning, including Personal and Professional Development Planning (PPDP) and work portfolios.**

   Students need to know how they can improve their levels of achievement. They should be able to identify their own strengths and weaknesses, plan a strategy for addressing the latter and report on progress made toward this. A supported system to provide a framework for such a process should be in place.

   Students may also benefit from the compilation of a portfolio, which may include a collection of their work, with a commentary, as well as the above. The portfolio may be physical, electronic, or be a combination of both.

3. **Career Management Skills (CMS)** - likely to involve the university careers service.

   It is important that students know what career paths are available to them, and have the necessary skills to gain access to them. The key CMS skills required are:

   - Knowing how to write a good CV, sourcing job opportunities, researching the company, preparing a good job application, interview types and activities, handling difficult interview questions.
   - Reflecting on work experience or placement and recognising their own achievements. Being able to articulate these skills, through oral or written presentations or through a poster.
   - Enterprise skills, entrepreneurship, innovation, commercial/sector awareness.

4. **Employability skills** - recognising that a degree is about more than the subject itself.

   Other skills that should be gained include:

   - Communication, Team-working, Leadership, Problem solving, Logical argument, IT skills and Numeracy.

   The following attributes are also desirable:

   - Self-motivation, Self-management, Self-efficacy, Adaptability, Reliability, Leadership skills, Self-articulation.

Appendix 2: Example of skill mapping through the levels of the course

The design of the course is such that there are opportunities both to practise and improve various key and professional skills, and to have them assessed, in a range of modules. A grid can show how this is structured:

Skill	Level 4	Level 5	Level 6
Problem Solving	All modules	All modules	All modules
Communication	Module 4.1, Module 4.2, Module 4.3, with practice in all modules	Module 5.1, Module 5.3, Module 5.5, with practice in all modules	Module 6.1, Module 6.2, Module 6.3, with practice in all modules
Reading maths	Module 4.1, Module 4.2, Module 4.3, Module 4.4, Module 4.5.	Module 5.1, Module 5.2, Module 5.3, Module 5.4, Module 5.5	Module 6.1, Module 6.2, Module 6.3, and in electives
Information gathering	Module 4.1, Module 4.2, Module 4.3.	Module 5.1, Module 5.3, Module 5.5	Module 6.1, Module 6.2, Module 6.3, and in electives
Using IT	All modules	All modules	All modules
Working with Number	All modules	All modules	All modules
Working with others	Module 4.1, Module 4.2, Module 4.6.	Module 5.1	Module 6.1, Module 6.2, Module 6.3.
Reflection and action planning	Module 4.1, Module 4.2, Module 4.3 and through all modules via the learning log	Module 5.1, Module 5.5, and through all modules via the learning log	Module 6.1, Module 6.2, Module 6.3, and through all modules via the learning log

Appendix 3: A Possible Employability 'Thread'

Year	Activity	Skills
Open day presentation introduces the importance of developing 'graduate' skills		
1	Discussion of skills at induction	Skill awareness
	CV-production	Self-awareness, career management
	Peer-Assisted Learning, group work, oral (group) and poster presentations	Teamwork, self-efficacy, problem solving, leadership
	Essay on study skills	Self-awareness, awareness of the 'wider picture', communication skills
	Employer Mentoring[1]	Career development/awareness
	End of year reflection on skill development	Reflection, self-awareness, recognition of progress
2	Interdisciplinary Project	Work-related learning, communication, interdisciplinary teamwork, negotiation skills
	Delivering small group presentations	Communication, teamwork
	Preparation and application for industrial placement: CV assessment self-appraisal employer awareness job-application skills writing covering letters answering difficult questions interview skills	Career development, career management skills Self-awareness, confidence
3	Industrial placement (*optional*)	Work-based learning, commercial awareness, time management, team working
4	Professional Development module industry and career awareness self-evaluation and reflection group presentation and poster individual poster presentation	Career development, teamwork, communication
	Peer-Assisted Learning (PAL) Leader	Leadership, self-management, adaptability
	Individual Project: oral presentation report oral examination	Problem solving, adaptability, communication, research skills, time management.
All years	Group work	Team-working, leadership
	Reflective learning diary	Reflection, action-planning, target-setting, self-organisation, self-awareness

[1] Employer mentoring is possible at any stage of the course

Appendix 4: A Typology of Modes of Work-Based Learning

It is possible to identify a number of modes or approaches to WBL:

Type of WBL	Objectives	Location/context	Duration
Sandwich work placement	Application of knowledge in a practical context; development of skills and attributes relevant to a professional / vocational area.	Company or organisation.	1-2 semesters up to a calendar year.
Integrated practice placement where the student may also be a trainee or employee.	As above; introduction to a community of practice; professional accreditation.	Block placement in a professional environment.	Up to 50% of programme, often divided into blocks.
Employment-based learning programme e.g. sector focused foundation degree.	Sector recognised vocational qualification.	Company or organisation.	In a work environment for most of the programme.
Assessment/ accreditation of learning from work outside university e.g. part time employment.	Integration of theoretical and practical knowledge; reflection on development of skills and attributes relevant to a professional / vocational area.	Company or organisation.	Can be short term (a few days) up to a semester or a full year.
Project with a commissioning organisation.	Application of knowledge in a practical context; project and client management skills.	Company or organisation.	Can be short term (a few days) up to a semester.
University Employability Award	Development of employability skills, in particular "soft skills".	Voluntary organisation.	Can be short term (a few days) up to a semester.
Residential/ block week activities with outside clients/ organisations	Application of knowledge in a practical context; project and client management skills; working under pressure to a professional standard.	Company or organisation.	Usually several days.
Student Ambassador Scheme	Development of personal and interpersonal employability skills.	University	Open days etc. as required.

Table based on De Montfort University (2006, p. 4).

Case Studies

1. Psychometric test preparation workshops

Tim Crawford, Learning Development Service, Queen's University Belfast.

Skills addressed: numeracy, statistics, logic, verbal reasoning, spatial awareness, problem solving, confidence building.

Context

The Learning Development Service (LDS) provides four ways to support the development of students' mathematical and statistical skills.

- Workshops – thematic and specific. Typically the LDS tutor is invited to talk on a specific topic, e.g. a workshop for first-year medicine students on the use of Excel for statistical analysis.
- One-to-one appointments – individual consultation (one-hour duration). Feedback suggests this approach has the greatest impact on a student's academic performance. In 2015/16, 96% of students who had a one-to-one appointment said it made a positive impact on their academic performance.
- Development of online resources – students are directed to self-study material to enhance their skills (including employability skills).
- Drop-in sessions – the aim is to meet a student's need in their specific area of study. These target specific groups, e.g. first-year engineering students.

Implementation

Workshops on preparation for psychometric tests were organised by the University's Careers Service and delivered by the LDS tutor. There were three workshops covering numerical, verbal and diagrammatic reasoning. The workshops were offered to all students at all academic levels with students free to sign up for all three workshops or just particular ones suited to their requirements. The workshops were of duration 1.5 hours and held at lunchtime. This year, 60 students attended the numerical and verbal reasoning workshops while the diagrammatic reasoning workshop was less popular with about 20 students attending. An open-plan room was used for the sessions but the format would work in a lecture theatre. The Socrative classroom app (www.socrative.com) was used to make the sessions interactive; students could use their mobile devices to ask questions, make comments and obtain instant feedback. While the students were working individually rather than in groups, the tool was very effective in promoting engagement with the topic. Follow-up practice material was offered to students. Numerical reasoning resources, developed in-house and available on the LDS website, consist of a bank of questions in which the numerical values of variables change whenever questions are used repeatedly. The dynamic nature of the questions encourages more practice and the instant feedback on instruction helps consolidate skills and leads to good feedback from students. Students had opportunity to make a one-to-one appointment as follow up to a workshop.

There was a lot of interest in the workshops so they need to be offered more frequently and delivered multiple times. The relevance of the workshops is seasonal (dependent on job application times) so it is proposed that workshops might be offered in future in October, end of November and around Easter time. Times other than lunchtime should be tried also. The LDS intends to have the workshop content and practice material online in future, so that virtual workshops can be implemented, and is keen to enhance online provision while retaining face-to-face workshops.

In addition to these workshops open to all students, the LDS has been asked to provide sessions for specific groups. For example, all second-year psychology students (220 students) were required by their School to attend a numerical reasoning workshop. While this had the same content and

structure as described above, it was held in a lecture theatre with the class attending as a single group.

Evidence and recommendations

Student evaluations of the workshops were conducted immediately at the end of the sessions using a paper-based feedback form. The sessions were very well received but a common theme was that they should be longer. A sample of student quotes follows:

- "Very useful as it was interactive. Could be a bit longer."
- "Very good idea and good resources used."
- "Socrative worked very well."

The following quotes are from student emails following support in numerical reasoning:

- "Thank you so much again for your time on Friday. Can't tell you how helpful it was and really do feel like a weight has been lifted off my shoulders, so thank you."
- "I would just like to say thank you for all of your assistance. I graduated on Tuesday with my MSSc with commendation. I've also filled in a questionnaire/feedback on the LDS and have commented on your excellent service."

Recommendations:

- make content available online to permit a wider audience to benefit from it;
- the face-to-face workshops should be longer in duration (2+ hours) and delivered more frequently;
- an interactive software such as Socrative should be used to promote engagement;
- the workshops should not be of a stand-alone nature – students should have opportunity to practise further after attending workshops and the option of a one-to-one appointment afterwards;
- as long as interactive software is used, the type of room used for the workshop is not critical – a large lecture room can be suitable;
- ensure that shortcuts to promote both accurate and efficient performance in psychometric tests are demonstrated – it might be necessary to teach the use of the memory function on a calculator;
- provide tailored sessions depending on job disciplines. For example, while tests for IT jobs have generic numerical and verbal reasoning questions, they also usually have diagrammatic questions since problem solving and visualisation are key skills. In contrast, accountancy tests focus on graphical and tabular questions.

References/more information

LDS resources on numerical reasoning:
www.qub.ac.uk/directorates/sgc/careers/StudentsandGraduates/CVsMakingApplicationsandInterviews/PsychometricTests/.

2. Is Numeracy my Business? Investigation into Improving Numeracy for Level 4 Business Students

Dave Faulkner and Frances Whalley, Business School, University of Hertfordshire.

Skills addressed: numeracy skills relevant to the above: number, ratio and percentage, algebra and interpreting data.

Context

Research has shown that many undergraduates enter university lacking the numeracy skills necessary for their courses. Furthermore, employers demand that applicants for graduate level jobs should be numerate and many use data interpretation tests as part of their recruitment process.

Implementation

In our study, through the use of diagnostic tests and questionnaires, we investigated the effectiveness of preparatory materials in improving numeracy skills and identifying student weaknesses.

Using a variety of sources, including material relating to employers' numeracy tests, we attempted to identify the key numeracy skills required by our Business students. Then we developed self-study revision materials suitable for preparing our students for both their Level 4 quantitative methods module and employers' numeracy tests. These materials were in the form of PowerPoint revision slides and online quizzes which were presented in a Business context to encourage students to appreciate the application of mathematical skills.

At the start of their quants module over 200 students were either allocated to a Test Group, who had access to the revision materials prior to the diagnostic numeracy test, or to a Control Group who did not. Students were informed of the diagnostic test (paper based) 7-10 days in advance. The test results and appropriate targeted advice (e.g. to seek support) were communicated to students within a few days. Students then gave feedback via our first questionnaire. Later in the module students did an Employers' Numeracy pre-Test to introduce them, in a gentle way, to the style of tests many employers use. Students then completed a second questionnaire.

It should be noted that out tests did not form part of the quants module assessment.

Evidence and recommendations

We found that, when students engaged with the revision quizzes only, the mean diagnostic test score showed a slight increase. However, when students engaged with both the targeted revision PowerPoints and the quizzes, they scored significantly higher in the diagnostic test than students without access to these materials.

Over 150 students attended the diagnostic test but attendance fell for the Employers' pre-Test later in the module when students had assignments to complete. Our study indicates that, although students recognise that they need support in order to improve their numeracy, some lack the self-motivation required to engage and a more structured support mechanism could be advantageous. We recommend that:

- preliminary revision materials should be made available prior to the diagnostic test; this could be via a link to the Support Centre website and would have the added advantage of enabling the numeracy support available to be publicised;
- students should be encouraged to engage fully with preparatory materials so that genuinely weak students can be identified and support offered at an early stage; students needing support should be given an appointment with a named member of the Support Centre staff;
- the diagnostic test would be most effective early in the semester when

students are engaged with learning activities but are not overwhelmed with assignments;
- tests could be administered:
  - on paper under test conditions;
  - online, using a suitable software package; individualised questions could be used to discourage collusion;
- to encourage engagement with the tests, student participation should be monitored with absentee follow-up giving appointments for future test sessions.

The feedback from students obtained in our study indicated that they wanted targeted resources, directed teaching support and regular practice to help them to work towards the level of numeracy and data interpretation skills valued by employers. We recommend that:

- a structured programme may be appropriate;
- a short course could be introduced covering basic numeracy theory and data interpretation techniques; the course would include regular practice tests, gradually working towards employer-style numeracy tests;
- this course may well be non-credit bearing; however, results could be published on the student transcript and would demonstrate to employers a continuing participation with numeracy and data interpretation;
- our study suggests that students would prefer online provision;
- regular, mandatory practice of data interpretation techniques embedded throughout university Business courses could help to improve numeracy.

References/more information

For further information please contact Dave Faulkner (d.j.faulkner@herts.ac.uk) or Frances Whalley (f.e.whalley@herts.ac.uk).

3. Refresh Your Maths

Julia Paci (CSSIS), Jake Hibberd (SEAS, formerly CEMPS) and Rachel Canter (SEAS), Mathematics Department, College of Engineering and Physical Sciences (CEMPS), the College of Social Sciences and International Studies (CSSIS) and Student Employability and Academic Success (SEAS), University of Exeter.

Skills addressed: basic maths: fractions, ratios, percentages, graphs and numerical reasoning; exam / test strategies.

Context

A need was identified to up-skill Humanities and Social Sciences students, giving them the tools, confidence and ability to attempt numerical reasoning tests for graduate scheme applications. According to a report by the British Academy, "About seven in ten employees in the UK economy say that QS [Quantitative Skills] are essential or important to carry out their work" (Mason, Nathan and Rosso, 2015; p. 10). A secondary aim of the project was to further the development of general academic skills such as exam or test strategies which would support students in their wider academic learning.

Implementation

The first step was to identify key areas to cover in the workshops by consulting with students and careers consultants and looking at the content of numerical reasoning tests. Existing maths support programmes at the University had indicated that there would be a need to pay the peer tutors for their time. The University's Annual Fund (alumni funding) supported the pilot project and its success has led to further University funding this year. This is allowing the project to expand to benefit students from all disciplines across three of the University's campuses in this Peer Assisted Learning programme.

A plan for two different workshops was developed in year one: a 90-minute workshop covering basic mathematical skills, and a 60-minute workshop on practising numerical reasoning tests. A 60-minute workshop specifically tailored to the numeracy test for PGCE applications was also offered.

Students who had previous experience of peer mentoring were recruited from the Mathematics department to offer peer support for this programme. Support from staff in the department was crucial in enabling this recruitment to take place. In the second year of operation staffing had changed and there were fewer applications from students, highlighting the importance of building and maintaining close collaborative relationships.

The peer mentors were involved in a 3-hour training session covering what employers are looking for when setting numerical reasoning and numeracy tests and where to access resources. The first part of this invaluable training was run by a careers consultant. Based on the pilot feedback, a 2.5-hour 'train the trainer' programme was also delivered this year, which has already seen improved feedback regarding session delivery. Peer mentors can also access on-going support from staff involved in managing the project.

The workshops were advertised to students via the University's careers portal. Attendance is monitored and feedback collected from those involved at the start and end of the project. Maintaining the visibility of the project has been challenging and requires a continual marketing presence.

As part of the pilot programme, the team were able to create a set of resources. Videos, practice mathematical questions and links to other resources are now available to all staff and students on the University's virtual learning environment (VLE). At the end of the pilot year a report was written for University management

both in the Alumni Giving and Student Employability and Academic Success Directorates, incorporating feedback from all those involved and suggestions for improvements for the second year.

Evidence and recommendations

Evidence and recommendations have come from both the peer mentors and from the students who attended the sessions. In the pilot year, 36 students attended. This year 60 students have attended (term one, as of 23/11/2016), already exceeding last year's figure and the support is due to continue until February enabling further students to benefit.

Analysing this year's feedback is in progress. However, last year's feedback suggested that the workshops contributed to students reporting an increased confidence in their ability to complete numerical reasoning tests. As Croft, Grove and Lawson (2016, p. 3) point out, it is important that issues of confidence are addressed alongside "technical knowledge".

The following is a comment from a Politics undergraduate student: "I went to the Refresh Your Maths workshop yesterday and it was super!! It was so helpful and really gave me some confidence! I was wondering whether I could book a session for next week? I am in the middle of doing applications and really need all the help I can get as soon as possible! Many thanks."

Recommendations from the pilot year:

- to invest in the programme in terms of recruiting and paying student mentors, marketing and administration;
- to improve and develop the online resources with more practice mathematical questions;
- to track the graduate destinations of students who attended the course.

References/more information

Croft, T., Grove, M. and Lawson, D. (2016). *The oversight of mathematics, statistics and numeracy support provision at university level: A guide for Pro-Vice-Chancellors*. **sigma** Network, Loughborough University and HEFCE. www.sigma-network.ac.uk/wp-content/uploads/2016/10/66141-Senior-Management-Handbook-AWK-WEB.pdf.

Mason, G., Nathan, M. and Rosso A. (2015). *State of the Nation: A review of evidence on the supply and demand of quantitative skills*. London: British Academy.

4. *Numeracy Skills for Employability and the Workplace*, a free online course on the FutureLearn MOOC platform

Janette Matthews, Mathematics Education Centre, Loughborough University.

Skills addressed: preparation for employers' numeracy testing (e.g. context, types of tests, preparation, confidence) and revision of numeracy skills (e.g. fractions, percentages, ratios, averages, currency conversions, interpretation of numerical data, understanding statistics, using a calculator).

Context

Numeracy Skills for Employability and the Workplace is a free online course developed for the FutureLearn MOOC platform by Dr Janette Matthews and Professor Tony Croft with material on statistics by Dr Alun Owen. The three-week course is designed for independent study.

The course aims to prepare learners both for employers' numeracy testing and for numeracy required in the workplace. Learning materials consist of animated video tutorials with transcripts, onscreen articles, quizzes with feedback, practice test examples with worked solutions, a course test, forums to ask questions and share experiences with other learners[2], links to other resources e.g. **math**centre, **stats**tutor and the National Numeracy Challenge.

Course materials may be studied at any time[3] and at a learner's own pace. Elements may be omitted or repeated as often as needed. All materials remain available online indefinitely.

The first week is a gentle introduction to numeracy and an exploration of numeracy questions in the context of employers' tests. The rationale for tests is addressed. Learners are encouraged to assess their own strengths and weaknesses. The first week also includes revision on using a calculator, rounding and approximating and a start to building an approach for responding to questions. An important part of the first week is recognising numbers in daily life and issues concerning mathematical confidence and includes a video by Professor Tony Croft.

The second week addresses numeracy skills. Fractions, decimals, percentages, ratio and proportion, unit and currency conversion are all covered. After each topic, there is a quiz with detailed feedback to test knowledge and understanding.

The third week addresses data interpretation. Materials cover tables and a variety of graphs (pie, line, bar, box plots and scatter plots). Learners are given the opportunity to practise numeracy calculations from week 2. Week 3 also contains materials which cover averages and an introduction to statistics. There is an opportunity to practice some numeracy test style questions both with and without a calculator, followed by the course test.

Learners who complete all three weeks should be able to recognise which numeracy skills and data are needed to answer a question. They will have gained experience in strategies for answering questions and working more quickly and should feel more confident.

Implementation

Numeracy Skills for Employability and the Workplace is implemented on the FutureLearn platform. Learners will need to register with FutureLearn (www.futureLearn.com) and join the next presentation of the course from this link www.futurelearn.com/courses/numeracy-skills. There are normally two presentations per year (March/April and September/October). If registration for a course is not open, it will be possible to

[2] Forums are monitored by course educators during the period a course is open.

[3] Learners must be registered with FutureLearn and have joined the course.

register interest to be notified when the next course is open for registration.

Evidence and recommendations

Numeracy Skills for Employability and the Workplace has been presented 5 times to-date (June 2015, October 2015, February 2016, July 2016, October 2016) and has attracted almost 17,000 learners[4]. Her are a few comments from learners who have completed *Numeracy Skills for Employability and the Workplace:*

- "Very intensive three weeks, but they were really worth! I found this course very useful, as I was able to refresh all the knowledge I already had, but that I wasn't able to use in a day-to-day basis. The quizzes are very useful, without practice we would not be able to achieve all the necessary skills. I believe the only thing left to do is keep on practicing to get faster at replying all the questions, but that is up to us now. Many thanks!" (Agnes Audelas, 30 November 2015)
- "Thank you for this excellent course. For me the most important lesson was to read the question and look at the data carefully. Quality over quantity." (Anne Barclay, 19 November 2015)
- "Very useful quizzes, practice and reminder of terms (especially the statistical elements). Some useful pointers on 'things to look out for' and quick approximations to aid with speed (which is my biggest concern area). Overall an excellent use of time and well worth the time spent. […]" (Carl Jones, 15 February 2016)
- " [….] I simply cannot express adequately the revelation that this course has been to me. I first understood in primary school at the age of 4 1/2 that I had enormous difficulties with numeracy. I wasn't brilliantly taught and never developed the slightest confidence or feeling for numbers. From the very first steps of this course a door has opened for me. I'm astounded at how enthralling I found everything that I was learning. I followed each video slowly, challenging myself to work on the problems step by step before the working was explained. I enjoyed the quizzes and to my amazement got totally caught up in the fascinating logic of working with numbers. I was especially appreciative of Janette's clear and detailed tuition, going back to absolute basics when necessary but also covering wider topics and applications. Thank you all so much." (Kate Webb, 14 November 2015)

References/more information

See www.futurelearn.com/courses/numeracy-skills for more information or contact Dr Janette Matthews (J.Matthews@lboro.ac.uk).

[4] FutureLearn course statistics to 29 November 2016.

5. School of Mathematics, Statistics & Actuarial Science Employability Programme

Mark Heller, School of Mathematics, Statistics & Actuarial Science, University of Kent.

Skills addressed: a range of employability-related skills.

Context

Students increasingly see their university programmes as a pathway to successful graduate employment, and there is an increasing expectation that universities will provide students with the opportunities to develop a wide range of employability skills and knowledge.

However, despite this, many students tend to be rather apathetic about taking action to develop these skills and knowledge, in many cases believing that this is something that can be dealt with in their final year.

Regrettably, this is often too late, and can result in students not being able to obtain the graduate roles they want.

Recognising this as a problem within our school, we set about creating an employability programme that would start when students enter university, and follow them through the various stages of their university programme.

Implementation

One of the key issues within our school was a lack of resources, and also a narrow range of employability-related knowledge amongst academic staff.

To overcome this, we worked very closely with the university's careers service, who were able to advise on suitable programme contents, as well as providing resources to deliver some of the seminars and workshops.

Induction

We felt it was important that students were aware of the importance of developing employability skills from the very beginning of their university life, and so we incorporated employability presentations into fresher week activities for new students.

The induction presentations highlighted the competitive nature of graduate roles, and set out the types of skills, knowledge and experience that students should be looking to develop over their time at university.

We also ran refresher presentations for all returning second and third year students, reinforcing the importance of developing employability-related skills over the course of their studies – not just when it comes to looking for a job.

Employability Programme

The second element of our employability offering was to develop a structured programme offering students employability-related material at appropriate stages in their development.

The programme begins in the first year helping students to develop strong dynamic CVs, to reflect on possible future career paths, and to reflect on how they might develop the relevant skills, knowledge and experience to achieve their objectives.

In the second year, there is more emphasis on gaining practical experience, focusing on internship and industrial placement opportunities, as well as opportunities within the university such as mentoring and class representatives.

In the final year, the focus moves towards developing the specific skills needed to successfully navigate graduate recruitment processes – for example, interview, presentation and assessment centre skills. Information and guidance is also provided for those considering pursuing higher level academic qualifications.

The programme has been widely promoted to students, and supported through a modern communications strategy, using

social media in addition to traditional e-mail communications.

Curriculum-Embedded Material

The final goal of our employability offering to students is to embed employability-related topics into the curriculum. This has the dual advantages of ensuring that the maximum number of students participate in employability activities, as well as raising the profile and importance of employability.

To date, this has only been possible for final year undergraduate students, but there are plans to implement employability topics into the curriculum from the first year onwards, allowing us to build a progressive and coherent employability programme for all students.

6. Employer-endorsed employability assessment

Noel-Ann Bradshaw, Department of Mathematical Sciences, University of Greenwich.

Skills addressed: confidence, CV writing, job applications, competency-based questions.

Context

Generally, mathematics students find it hard to appreciate the variety of careers that are available to them and struggle to understand the different stages in the graduate recruitment process and how they need to prepare for them (Hibberd & Grove 2006). The Department was aware that those students who applied for sandwich placements (regardless as to whether they were successful) came into the final year more prepared for the graduate job-market than those who had never completed a graduate-level job application. Also students' ability to reflect on their skills and competencies needed improving.

Implementation

To address these issues the Department developed a Personal Development Planning (PDP) assignment in a core second year module Operational Research (Bradshaw, 2014). This included:

- initial skills audit and research on careers in mathematics, statistics or OR;
- preparing a CV, job application and covering letter;
- application for an internship and/or involvement in the Department's IMA Business Game;
- creating a LinkedIn profile;
- reflection and planning for the future.

The students were given a short lecture introducing them to the Maths Careers website (www.mathscareers.org.uk) and a career building platform from Abintegro (www.abintegro.com). There was also some teaching on the basics of job applications, competency-based interviews and LinkedIn. When researching a specific company students were asked not to write about teaching. This is because it is felt that any would-be teachers need, for the benefit of their future students, to be just as aware of the breadth of companies that employ mathematics graduates and the skills that maths graduates have to offer.

Barriers

In a previous iteration of this assignment students were given the opportunity to upload a draft version of their CV to obtain feedback on it before uploading a final version (Bradshaw, 2014). This was incredibly beneficial for the students but the marking load was far too time-consuming to sustain. The marking of the assignment is still an issue but it is thought that its usefulness to students outweighs the burden on staff. The assignment requires students to complete a LinkedIn profile (in accordance with the University's policy on Social Media). However, some students do not feel comfortable doing this for various reasons so provision has been made for students to create a fictitious profile without losing marks on the assignment, showing that they understand how to create a good profile and understand the need to show prospective employers the range of skills and competencies that they have.

Enablers

Over the years the assignment has changed to encourage student engagement in other Department- and University-based employability events. These include the IMA Business Game (Bradshaw, 2013), a regular event for second year students, and also involvement in activities run by the East London Business Association (ELBA). Although all of these activities are well thought of by some students it is not always easy to get sufficient numbers taking part when students are focused so much on assessed coursework. By making attendance at one of these events part of the PDP assignment, engagement with them has increased. Students are required

to include their reflection on what they obtained from such events as well as evidence that they actually attended. This reflection helps them to understand the benefit that participating in these events can bring.

Some students commented in the past that applying for one of the chosen jobs with a completed application form, cover letter and CV is a lengthy process and not so necessary for students who have completed several applications for sandwich placements. Therefore provision is made for students who have completed several placement applications to submit a copy of one of these as long as it contains a cover letter, a CV and an application with answers to at least three competency-based questions.

Evidence and recommendations

Feedback on this assignment has been sought from a wide variety of people including employers, graduates and external examiners. One employer said "I think you have an excellent model…I especially liked the Standard Application Form which should, if well thought through by the student, prepare them for almost any formal application". Many students also said that without this assignment they did not feel that they would have obtained a placement after their second year or known what they needed to do regarding applying for graduate schemes at the start of their final year.

The feedback from employers has been particularly important in gaining student buy-in for the assignment. The positive feedback from previous cohorts of students has also been very valuable in this regard. Student comments have included: "I thought that being asked to make a CV and a covering letter as part of the coursework was excellent, as many people would already have a CV but just didn't realize how much of an impact this has on being given the opportunity to have an interview with a company. I have now been motivated to go out and apply for more placements as well."

This assignment is not going to make an impact on the Department's Destination of Leavers of Higher Education Survey results on its own, but as part of a number of interventions, including those run by the University's careers team, it can help more mathematics graduates obtain graduate-level work.

References/more information

Bradshaw, N. (2013). The IMA Business Game. *Mathematics Today*, 49 (1), p. 27.

Bradshaw, N. (2014). Employer-endorsed employability assessment. *HEA STEM 2014*, Retrieved 05/07/2017 from www.heacademy.ac.uk/system/files/resources/msor-130-paper.pdf.

Hibberd, S. and Grove, M. (2009). Developing graduate and employability skills within a mathematical sciences programme. *MSOR Connections*, 9 (2), pp. 33-39.

7. Employability sessions for Mathematics students

Karen Henderson, Alison Hooper, Tilly Line, Wendy Fowles-Sweet, Department of Engineering Design and Mathematics, University of the West of England, UWE Bristol.

Skills addressed: graduate development, careers support.

Context

We present details of the graduate development and careers support sessions provided for students on our Mathematics-based programmes. The schedule described below was introduced four years ago and was set up in order to better prepare our students for placement opportunities as well as for future careers. Prior to the scheme, feedback from potential employers indicated that our students lacked confidence and were not selling themselves. In particular, students needed coaching on how to get a job and to prove to potential employers that they had the skills to get a job. The introduction of the careers team-led sessions coincided with a new careers service being offered at UWE Bristol. UWE Bristol's Careers and Enterprise Team won the prestigious National Undergraduate Employability Award 2014 for Best University Careers/Employability Service.

Implementation

The programme has been evolving over several years and is presented to all students in the Department of Engineering Design and Mathematics. It comprises a mixture of whole group sessions, delivered across the department, together with cohort sessions, for just our own mathematics students. The programme is introduced to students in induction week and reinforced by Academic Personal Tutors. The first formal sessions currently take place half-way through the second semester of Level 1 held a week apart and comprise two extra-curricular time-tabled cohort sessions run by the careers team. Details of the content are shown below.

Year 1

Session 1: Know Yourself - What do you want to do? Exploring the world of professional work;

Session 2: Action Planning.

It is important to raise awareness of, and for students to realise the importance of graduate development early in their studies. These sessions used to be held in Level 2 but, after consultation with student representatives, we recognised the benefit of holding them in Level 1. In particular, students were able to use the summer to prepare; they could improve their CV, look for and achieve short internships to gain early work experience and start the second year with a better understanding of the merits of applying for year-long placements.

The Level 2 sessions start as soon as students return to University with a departmental Introduction to Professional Development followed by mathematics cohort sessions as shown below.

Year 2

Session 1: Know Yourself - Establishing your 'professional' starting point;

Session 2: Know Your Options - What is your current professional profile?

These sessions are followed by four whole group weekly Employer Talks sessions. Each week three employers are invited to lead a panel discussion on a particular subject followed by a Question and Answer session. Employers who are of interest to students across the department are selected, that is to appeal to Engineering and Mathematics based students. For example, in one week employers from Babcock, the Office for National Statistics and Hydrock were represented. The employers are invited to bring along a placement student and any available live placement opportunities. Further whole group sessions explore academic postgraduate opportunities and professional recognition.

Year 3

In Level 3 we run a cohort session on 'Getting Ready for Graduation' and further sessions are planned which will be especially useful for students who have not previously engaged with the Graduate Development programme as they realise that they need to think about getting a job/other roles.

One of the main challenges is to get students to engage with this extra-curricular Graduate Development programme. Despite this, there is raised awareness of the careers service evidenced by the high take up across the department of careers drop-in sessions by our students. In one of our core second year modules, prospective employers demonstrate within some class-time what they do in a typical working day. Invited employers have recruited from our graduates before and are often UWE alumni. This enables students to find out from past UWE Bristol graduates about opportunities. Class time is also offered to current placement students; this connection works very well in engaging students by removing perceived barriers.

Across the department 20–25% of students go out on placement annually. We aim to increase this as opportunities are there, and because of the fact that students who go on placement tend to perform very well. For those that do not go on placement, there are many other employability activities in which they can participate to help them improve their graduate profile such as volunteering opportunities and being a student ambassador. Employers value this and students can evidence their engagement through their HEAR report and the UWE Futures Award.

Evidence and recommendations

Student feedback following each teaching session/employer panel indicates that there is an increase in knowledge and confidence across the attendees, with regard to factors such as 'the concept of professional development', 'how to plan and manage professional development', 'how to evidence professional skills', 'how to research work opportunities', and 'how to write an effective action plan'. Destination of Leavers in Higher Education (DLHE) data for our Mathematics graduates, shown in figure 1, points to evidence that our practice is working, with improvements over the last four years.

We recognise that students mature at different times, so regular exposure to information about careers is vital from level 1 onwards. Also, we have a very diverse student intake, with varying levels of social mobility and capital; these also impact on engagement and their choice of timing to engage. Students may freely access the careers services throughout their time at UWE Bristol and for three years after graduation.

References/more information

UWE Bristol Careers and Employability: www.uwe.ac.uk/careers.

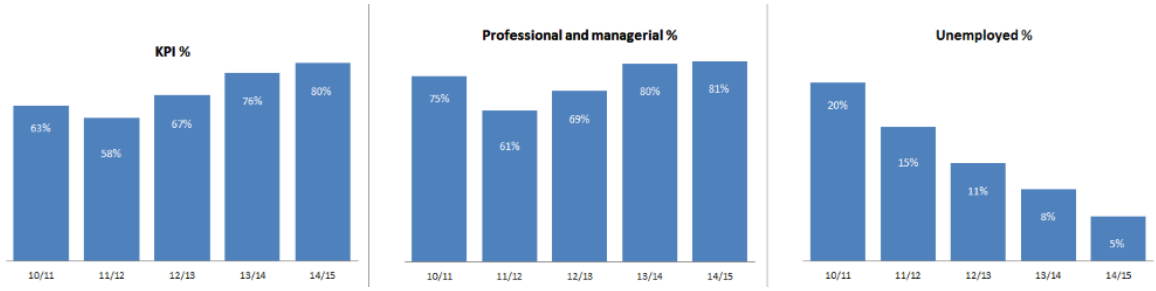


Figure 1: Destination of Leavers in Higher Education (DLHE) data for our Mathematics graduates

8. MA199 Mathematics Careers and Employability

Edward A. Codling, Department of Mathematical Sciences (DMS), University of Essex.

Skills addressed: planning & reflection, self-awareness & confidence, key employability skills, knowledge & experience of the world of work.

Context

After a range of departmental and institutional reviews between 2008 and 2011, the University of Essex implemented a new University-level Employability Strategy to address the growing problem of poor (relative) employability statistics of our recent graduates. The Department of Mathematical Sciences (DMS) was pro-active about this employability focus and was one of the first departments to create an employability strategy plan and design a novel employability module (MA199) to engage students. In fact, features of the MA199 module had some direct input into the overall University Employability Strategy, and the underlying module structure is now one of the three options offered to departments as a way of embedding employability within their curriculums.

MA199 was introduced in its current format in the 2012-13 year and was compulsory for all 1st year mathematics students starting that year (including joint honours students). Students in years 2 and 3 at the time were not enrolled but were offered the module as a voluntary option. The module was originally structured around a series of weekly 1-hour seminars, but after detailed student feedback the module was modified in 2015-16 to consist of a smaller number of longer (2-3 hours) and more intensive workshops that run twice per term. Each workshop is linked around a specific assignment that students are able to fully complete and receive immediate feedback on during the session. Additional short 1-hour seminars on specific topics (e.g. placements, mathematics teaching, etc.) are run on a fortnightly basis between each workshop. This new format received unanimous positive support from students when surveyed, and hence was repeated in 2016-17.

Implementation

The MA199 module has a different structure to all other University of Essex modules. It runs over all 3 years of the degree and is zero-credit, meaning that although it appears on the final transcripts of graduating students (as 'Distinction', 70% or higher; 'Pass', 40% or higher; or 'Fail', <40%), it does not count directly for the final degree mark. This zero-credit module structure was originally implemented as we did not want to remove any mathematical content from our main degree schemes. A zero-credit module running over 3 years was novel and very much non-standard within the University, and we had to lobby hard to have it accepted. Significantly, now that the module has been shown to be successful, it has been adopted by the University as one of the best practice examples of embedding employability.

Consistent with published employability best practice (e.g. Knight & Yorke, 2003; Dacre-Pool & Sewel, 2009), we split the learning outcomes of the module across the developmental cycle of a student over their 3 years of study. In their 1st year, the assignments and workshops are built around self-reflection, self-awareness, and planning & development. In the 2nd year, the emphasis is on developing new skills and experiences, and building on the self-reflective elements of the first year, filling gaps and strengthening skills. In the 3rd year, the emphasis is on putting things into practice, with assignments carrying large amounts of credit focussed on applications for jobs or further study, and creating and presenting a detailed portfolio of examples of skills and experiences. The 3rd year carries most of the assessment weight (55%)

so that students can still catch up even if they don't engage fully in their first two years. The assignments are based on reflection and critical analysis of activities within and outside their degree and how these relate to employability. Students are encouraged to undertake extra-curricular activities such as volunteering, part time work, placements & internships, and the value of these are signposted within each assignment. The workshops and seminars are run by department staff with help from the central Employability and Careers Centre, and usually include one or more external speakers (e.g. alumni, employers, Institute of Mathematics and its Applications, etc). A 'Maths Careers Day' in the autumn term features four alumni speakers who students can meet and network with on a one-to-one basis.

Evidence and recommendations

Anecdotally there has been a clear progression of student engagement and their attitude towards the MA199 module over time. The recent change to a workshop format has improved student engagement and allowed space for more informal discussion which students appreciate. The vast majority of students who have completed the module have passed or received distinctions, but there is a small minority each year who fail to engage with the module and we may need to develop alternative strategies for these students.

One of the main issues we have overcome is student confidence and aspiration. Many of our students were not applying to the highest profile graduate opportunities and were settling for roles classified as 'non-graduate level' in the Destinations of Leavers from Higher Education (DLHE) survey. In addition, we have supported students to gain work experience and many have now successfully undertaken external or internal work placements. This active focus on employability has led to a clear improvement in our DLHE results since 2012 (see figure 1).

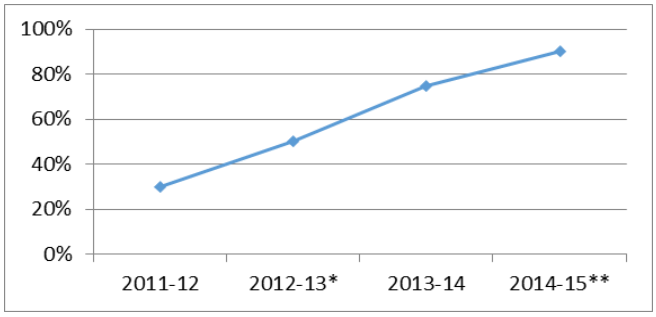
We have had a dramatic increase in graduate employability outcomes on a year-on-year basis; a figure of 90% in 2015 means we are now in the top 4 UK mathematics departments nationally for employability outcomes (Guardian University league table, 2018). More importantly, this improvement in graduate outcomes reflects the fact that our students are leaving university better prepared and more confident about their abilities and potential, and are able to achieve success as they enter the world of work or go on to further study.

References/more information

Dacre-Pool, L. and Sewell, P. (2007). The key to employability: developing a practical model of graduate employability. *Education and Training*, 49(4), pp. 277-289.

Knight, P. and Yorke, M. (2003). *Assessment, Learning and Employability*. Maidenhead: Open University Press.

Graduation Year	DLHE result
2012	30%
2013*	50%
2014	75%
2015**	90%



*MA199 was introduced in its current format in the 2012-13 year to 1st year students only. **The 2015 cohort were the first to graduate having completed all 3 years of MA199.

Figure 1: Destination of Leavers in Higher Education (DLHE) results since 2012.

9. Maths Graduates: Where are they now?

Noel-Ann Bradshaw, Department of Mathematical Sciences, University of Greenwich.

Skills addressed: confidence, career choice, understanding the job market.

Context

Inspired by Louise Walker's *Calculating Careers* event held at the University of Manchester (Walker, 2011), the Department of Mathematical Sciences at the University of Greenwich obtained funding from the National HE STEM Programme Mathematical Science HE Curriculum Innovation Fund to run an event called *Maths Graduates: Where are they now?* (Bradshaw, 2012). The plan was to invite fairly recent graduates to talk to current maths students about their job, how they obtained it and which parts of their studies they had found particularly relevant and helpful. Despite the mathematics degree at Greenwich containing considerable curriculum content on the variety of careers available for mathematics graduates, students still do not fully understand and appreciate the breadth of careers open to them, or how to find and apply for positions. This event, which first ran in 2012, has now become an annual occurrence and takes place within a core second year lecture slot.

Implementation

The event is run in February each year and is promoted mainly to second year students although first and final years are also invited. In the first term the second year students undertake some of their own research on mathematics careers and complete a practice job application as part of the Personal Development Planning (PDP) element in the Operational Research module (Bradshaw, 2014) (for further details see case study 6 in this collection).

Generally, about six graduates speak at the event. These graduates are chosen with a number of factors in mind. Firstly, it is important to have a wide variety of careers represented – if the event is in half term then it is usually possible to invite a teacher, which is appreciated by the students since teaching is an important career option for many of them. Secondly, the graduates' backgrounds are also taken into account and care is taken to include a graduate who has subsequently obtained an MSc and another who has undertaken a placement year.

Over the years the careers represented have varied but generally each year the event includes graduates involved in data analysis, actuarial work, finance and teaching as these are the main fields that our students aspire to get into.

The event runs for a maximum of two hours. After a short introduction each graduate speaks for 10 minutes (they are kept strictly to time) with one of two short questions after each talk. At the end of all the talks there is a chance for a panel discussion. This usually starts slowly as the students are not used to asking questions in this format, but it soon gets going as the students realise the advantage of obtaining several graduate view points on a particular topic.

Barriers

On some occasions it has been hard to get an appropriate mix of graduates either in terms of career, gender balance or general diversity. The other main problem is the lack of understanding of the importance of the event by current second year students. The students see the list of careers and companies represented and do not think they look interesting enough or are relevant to them. They fail to understand that even if the actual job is not what they want to do, the story of how the graduate got there will be useful and compelling as is their experience of choosing final year options.

Enablers

To overcome the first issue, the department has put resources into maintaining links with

graduates through LinkedIn and other social media. Successful graduates are often reminded that it would be good to keep in touch and many spontaneously offer to come and give talks.

In order to increase student attendance and engagement the event is now held during a second year lecture so that all the second year students are able to attend. It is important that all staff advertise the event and that no member of staff does anything to imply that it is less important to attend this than it is to attend a purely mathematical lecture.

Evidence and recommendations

Feedback from students attending this event is always very positive. These include comments as to how helpful it has been hearing first hand from people just a couple of years older than themselves as to how they have obtained a graduate job and what sort of work they are now doing.

Staff often feel that students do not fully understand the advice that they are given about the graduate job market. Having obtained part time work fairly easily, students do not realise the complexity and difficulty of obtaining a graduate job. Hearing the same information from the graduates adds weight to the information that staff have provided.

It has also been helpful for students to hear graduates say what they have most valued from their degree. This often includes group work, programming and report writing, which are not necessarily the most popular parts of a mathematics curriculum.

The event has been used by some graduates to recruit for their companies and so has been directly responsible for boosting numbers on internships and in graduate positions. This was an unforeseen benefit which helps the promotion of the event.

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10. Videos showing Dos and Don'ts in competency-based interviews

Noel-Ann Bradshaw, Department of Mathematical Sciences, University of Greenwich.

Skills addressed: confidence, communication skills, interview techniques.

Context

In January 2014, the Department of Mathematical Sciences hosted a day of mock interviews for their students with Stanton House, a recruitment agency for the financial sector (Bradshaw et al., 2015). The event was a success with very positive feedback from participants who felt that they had gained valuable advice from the professional recruiters. However some of the students who had registered in advance did not turn up. The reasons that these students subsequently gave showed that even though they understood that this was an excellent opportunity, they found the idea nerve-wracking and stressful. They lacked the confidence to take part in something unfamiliar despite the fact that a mock-interview at the University was intended to provide a safe environment to learn from.

One of the problems was that students at universities like Greenwich were not so familiar with the concept of a competency-based interview despite preparation for the graduation job market through a Personal Development Planning assignment (for further details see case study 6 in this collection).

It was suggested that videos showing good and bad interview behaviour and answers to competency-based questions might help, particularly if the examples given were based on university experiences which the students would recognise.

Implementation

Staff in the Educational Development Unit at the University of Greenwich were consulted and a script for the interviews was drafted. The result was that a series of short videos showing good and (intentionally) bad interview behaviour was created. These clips can be found on YouTube (Greenwich Connect, 2014a and 2014b): they can be played to students as short stand-alone snippets or watched together in a chunk. The questions covered are listed below.

1. Why have you applied for this job?
2. An example to demonstrate teamwork.
3. An example to demonstrate problem solving.
4. An example about technical skills.
5. An example showing good communication skills.
6. Questions from interviewee.

Barriers

Although the videos have gone down well with students more could be done to make the situation more realistic by having an interview panel with two or more members of staff interviewing a recent graduate. Having more people on the panel would have allowed different scenarios such as a male interviewee ignoring a female panel member.

Enablers

The students have appreciated seeing the sort of questions that can be asked at a graduate job interview and thus realising the need to prepare clear scenario-based answers. The use of humour has helped students engage with the videos. They are perhaps best used as the basis for discussion; students can debate how a 'poor' answer could be improved or why, for example, doing all the work in a group project yourself does not make you a good team player.

Evidence and recommendations

The videos have received very positive feedback from students.

However, if we were doing it again, we might involve students in the project, with a small team of graduates and coming up with a better script based on their real experiences. It would also be useful to have students or graduates from different backgrounds taking part.

References/more information

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11. Employability 2 – module for second-year engineering students

Jonathan Cole and Kathryn Fee, School of Mechanical and Aerospace Engineering, Queen's University Belfast.

Skills addressed: self-evaluation, preparation for job/placement applications, understanding of professional work environment.

Context

The Employability 2 module is optional for all second-year aerospace, mechanical and product design engineering students with 154 students enrolled in the 2016/17 year. The module is designed to enhance students' employability through the development of key skills and knowledge of employer expectations, and helps prepare students for the sandwich placement year. The module is provided through ten sessions of duration 1.5–2 hours on Monday afternoons in the first semester. It is delivered by the School's work placement officer with contributions from employer representatives in most weeks. The module is not credit bearing but appears on the students' transcripts as pass/fail based on attendance – a pass requires attending at least eight of the ten sessions.

This year, the session content has included a personal skills audit, CVs and applications, interview skills, psychometric testing, assessment centres and situational judgement testing, international opportunities, and digital citizenship. An additional session was converted into a speed networking event in which 11 local employers interacted with students to their mutual benefit.

The engineering degree programmes have a significant numerical content and are highly analytical in nature. Furthermore, there are many examples of practical, analytical, computational, presentation, team-working and research skills embedded over the curriculum within academic modules. Therefore, Employability 2 is not required to support numerical skills in particular. However, this case study focuses on one aspect of numerical skills development as provided through the session on psychometric testing.

Implementation

The session on psychometric testing was provided by a representative from EY (Ernst & Young). The session provided an explanation of what psychometric tests are and why they are used, and the different types of tests were described. Example numerical, verbal and diagrammatic questions were presented and students had time to test themselves during the class. Tips for better performance in such tests were offered. Thus, the session provided information and insight into psychometric testing, gave examples of test questions and directed students to resources. Moreover, students had subsequent opportunity to partake in practice tests online in numerical, verbal and diagrammatic reasoning and attend the University's Student Guidance Centre for further advice.

The module coordinator suggests that the session could be improved by having a more active approach to learning, encouraging more interaction and teaching at a deeper level.

Evidence and recommendations

The numbers of students undertaking the placement year has increased as follows: 54 in 2011/12, 71 in 2012/13, 80 in 2013/14, 106 in 2014/15, 142 in 2015/16 and 105 in 2016/17. This growth is believed to be largely due to the second-year employability module. The impact of these numbers is such that the proportion of students graduating with a sandwich degree has followed a strong upward trend in recent years, steadily rising from 23% in 2011/12 to 57% in 2015/16.

In their evaluations of the module this year, students frequently praised the company involvement and appreciated the useful and relevant advice and information. They enjoyed the speed networking event and personal CV checks. The following quotes are taken from module evaluation questionnaires:

- "Practical, lots of support, very helpful."
- "Learning what's best practice when applying for a work placement."
- One student, presumably referring to the work placement, stated that they "feel like this is an exciting opportunity."

Recommendations:

- employ guest speakers from companies to deliver some of the module content (e.g. psychometric testing, interview skills) rather than just a company presentation so that the content is presented in a relevant way;
- ensure that a variety of industry sectors (relevant to the students' degree programmes) are involved in the module;
- make use of alumni to encourage empathy between students and speakers;
- aim to make the sessions interactive, engaging and not too long (e.g. 1.5 hours maximum each week) to avoid fatigue over the course of a semester.

References/more information

Cole, J.S. and Turner, T. (2015). Developing employability within a university engineering curriculum. *Journal of the National Institute for Career Education and Counselling*, Issue 35, pp. 11-17.

QUB Careers Service website with resources on psychometric testing: www.qub.ac.uk/directorates/sgc/careers/StudentsandGraduates/CVsMakingApplicationsandInterviews/PsychometricTests/.

12. A Placement Learning Programme for Mathematics

Dafydd Evans, School of Mathematics, Cardiff University.

Skills addressed: reflection and PDP, employability skills.

Context

Cardiff University regulations require that undergraduate placement years are integrated into four-year degree programmes and contribute a minimum of 10% towards the overall assessment of these programmes. The regulations also demand that learning programmes are informed by the relevant professional, statutory and regulatory bodies, and that student engagement and wellbeing are monitored throughout the placement period.

Learning programmes for placement years are typically focused on how learning acquired in the classroom can be applied in practical situations. This is clearly appropriate for placements organised by the School of Engineering or the School of Nursing for example, but given the broad range of placements undertaken by students at the School of Mathematics and the highly abstract nature of the material covered during their first two years as undergraduates, our students invariably struggle to identify and express how learning acquired at University is applied in the workplace. For this reason, our placement learning programme does not address subject-specific skills directly, but instead is focused on developing professional competencies, reflective practice for continuing professional development and broad insight into different aspects of professional practice.

Assessment is mainly based on evidence, provided by students in the form of reflective accounts of their experiences in the workplace, that demonstrates achievement against the learning outcomes of the programme. Subject-specific skills are not assessed directly: students are not required to provide explicit evidence of their intellectual rigour and reasoning skills for example (QAA, 2015). Students are instead expected to demonstrate such subject-specific skills when articulating insight into professional matters more broadly, and are assessed accordingly.

Implementation

Learning programmes should be informed by the relevant professional, statutory and regulatory bodies, but neither the Institute of Mathematics and its Applications nor the London Mathematical Society have much to say about work-based learning. Our learning programme is therefore based on standards defined by the City & Guilds of London Institute (2017) as part of its Professional Recognition Awards (PRA) framework.

The assessment scheme has four components: a series of monthly journal entries (formative), a final placement report (80%), an oral presentation (10%) and a poster presentation (10%). The presentations are intended to promote the benefits of work placements to second-year undergraduates, and are assessed in the usual way. Journal entries and reports are assessed according to criteria based on Bloom's taxonomy of cognitive processes (Bloom, 1956).

Evidence of competence is provided by students as reflective accounts of how their employability skills have developed against the six categories defined under the City & Guilds framework. Such evidence can be assembled by operating only at the lower levels of Bloom's taxonomy. The extent to which reflective practice has developed is assessed according to the depth of reflection and action planning evident in journal entries and reports. To develop broad insight into different aspects of professional practice, students are encouraged to take a step back and discuss what they have learned about professional matters beyond the particular circumstances of their placement

experience. To provide evidence of insight, students are expected to demonstrate subject-specific skills such as intellectual rigour and reasoning, and operate at the upper levels of Bloom's taxonomy.

Among factors that enable the scheme is that journal entries are uploaded and assessed electronically on a monthly basis, which allows student engagement and wellbeing to be monitored throughout the placement period. The City & Guilds also has a comprehensive quality assurance process governing its Professional Recognition Awards, which has been invaluable in the design and implementation of the learning programme. Employers are also highly supportive of our objectives, and invariably encourage students to engage with the programme even when their own staff development programmes are quite different.

Among factors that hinder the scheme is that academic staff are mostly indifferent to the employability agenda, and cannot be relied on to promote the benefits of work-based learning opportunities to students. The learning programme is also necessarily rather vague, especially when compared to traditional taught programmes in mathematics, which amplifies student anxiety around assessment. Another potential barrier is that students invariably sign non-disclosure agreements with their employers, some of whom insist on reading students' submitted work to check that sensitive information has not been revealed. This may prevent students from writing full and honest accounts of their experiences, because they are likely to depend on their employers for references in future.

Evidence and recommendations

The benefits of our placement learning programme are often not appreciated by students until they return to the University and start applying for graduate jobs. Many students have said that their placement reports have been well-received at graduate job interviews, to the extent that we now encourage students to write their placement reports with this in mind.

Our learning programme has been well-received by employers.

"The learning outcomes of the placement year accurately reflect those which we are looking for in candidates, namely teamwork, strong communication skills, enthusiasm and motivation – including seeking opportunities to get involved, to grow and develop through taking positions of responsibility – and demonstrating commercial awareness." Placements Manager, Ernst & Young (2014).

The City & Guilds is satisfied with our quality assurance procedures.

"The work of PRA learners at the School of Mathematics were of a consistently high standard and clearly met the requirements of the qualification. The internal quality assurance systems being developed at the School are very encouraging. ' External Quality Assessor, City & Guilds (2016).

References/more information

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13. Embedding Employability in the Curriculum

Jeff Waldock, Department of Engineering and Mathematics, Sheffield Hallam University.

Skills addressed: communication, team-working, self-confidence, use of information technology, applying mathematical skills.

Context

The idea that the university experience should be about more than the degree itself is not a new one, but it's still one that few universities – especially within academic departments – promote in a meaningful way. At a time when graduates can expect to leave university with debts of upwards of £40,000, applicants are looking closely at what each course and institution offers – over and above the degree programme itself. High tuition fees lead to equally high student expectations, both of the qualification and the university experience. In challenging economic times these expectations are likely to also focus on graduate job prospects. As a result of this, and pressure from government, business and industry, many Higher Education institutions are adopting a renewed focus on the student experience and in engaging students as partners in learning. A common response of many HEIs has been to promote extracurricular activities, bursaries, awards and careers support; relatively little has changed within the curriculum.

A principal challenge for all institutions is to create an environment in which learning providers put employability enhancement at the heart of what they do, and recognise that some skills, practical job application skills for example, can be developed quickly and lead to short term gains in employment rates. Other important graduate attributes however, such as self-confidence, team-working and communication, take much longer but are equally in need of investment (Yorke, 2010). Institutions must therefore be willing to plan for long term gains as well as 'quick wins'.

Implementation

A key stage in the design of any programme of study is to identify the skills its graduates should possess. The mathematics course at Sheffield Hallam University (SHU) aims to prepare graduates for the job market, hence the range of skills is in part informed by employers and alumni. As stated in the Mathematics Benchmark Statement (QAA, 2015), all programmes should develop a range of generic employability skills alongside mathematical skills. Furthermore, it is often the generic skills that have the greatest influence of employability. The most important of these are:

- self-confidence, especially in tackling new challenges;
- self-awareness – knowing what you are good at, and being able to articulate and evidence this;
- problem-solving skills – knowing how to think creatively and apply existing knowledge and skills in new situations;
- the ability to communicate effectively and appropriately to different audiences;
- the ability to work with successfully with others – having inter-personal skills.

The course curriculum encourages the development of skills such as these without losing core content through the use of innovative LTA practice – the development of mathematics skills does not preclude the development of employability skills (see e.g. Yorke, 2006). Appropriate learning, teaching and assessment strategies can be chosen so that students gain generic and subject specific skills at the same time. It is important to make clear on each assignment brief what skills the learner is gaining from engaging with the task.

Being self-aware – recognising and being able to articulate and evidence skills – can be developed through reflective practice. Processes to support this, such as personal development planning, can also lead to greater levels of self-confidence since

students will be encouraged to reflect on their progress and look objectively at their developing abilities. A departmental approach that treats students as partners in learning, explaining the rationale for the curricular structure and how tasks have been designed to help them develop a variety of skills throughout their course, is more likely to lead to greater levels of engagement, satisfaction and, ultimately, achievement.

Mathematical modelling and project work provide vehicles for students to apply skills in new situations, think creatively and work in teams. Assessment tasks include writing and presenting – in various forms – to help students gain confidence incrementally throughout the course. Success at practical application of mathematics leads to greater levels of confidence and a greater willingness to tackle new problems.

Curricular tactics used at SHU to develop employability along maths skills include:

- a full placement year, developing a full range of workplace and professional skills;
- Progress Files – reflection and action planning, self-articulation and confidence building;
- delivering presentations – group presentations early in the course, leading to individual presentations at later stages;
- writing reports and creating posters – learning to communicate results in different ways;
- group work – learning to operate effectively as part of a team;
- a final year project that incorporates professional development and career planning;
- links with alumni, particularly through a LinkedIn group, for jobs and mentoring opportunities;
- essay writing – learning to organise ideas and present them effectively in writing;
- Mathematical Modelling as a thread throughout the course, showing maths in practice;
- embedded use of IT – Excel (+VBA), Matlab, SAS, custom software – including elements of experiential learning – through using technology ubiquitous in the workplace, students gain skills that directly improve their employment prospects;
- developing employability through the careful design of coordinated learning tasks – making the tacit explicit.

Evidence and recommendations

"Our group at xxx have developed a fantastic relationship with SHUMaths. SHU is now our University of choice for students and graduates as they are not only better equipped in terms of their skill set but are better prepared from interview onwards and demonstrate a mature, pro-active and strong work ethic. It is obvious the course is very much geared to making students employable."

Students graduating from the course are familiar with dealing with open ended problems, communicating the results in a variety of ways – orally, in writing, via a website and through poster presentations. They are adept at working in teams, proficient with technology, confident in using their mathematical knowledge in new ways and (if they chose to undertake a placement) able to evidence relevant work experience in their CV. Employers seem to agree, with 95% of our graduates in work or further study (DLHE 2015/16).

References/more information

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14. Progress Files

Jeff Waldock, Department of Engineering and Mathematics, Sheffield Hallam University.

Skills addressed: reflection, self-articulation, confidence.

Context

Students gain self-awareness by recognising their own development, and structured curricular processes that develop self-reflection skills enhance achievement and employability (Gough, 2003). In 1999 a bespoke online system to implement Personal and Professional Development Planning (PPDP) was created, requiring students to reflect on progress and make action plans for improvement. Theoretical foundation for this approach comes from the Understanding, Skilful practice, Efficacy and Metacognition (USEM) model of Knight and Yorke (2004). Unique in the sector, it predated the QAA Progress File initiative, and is referred to as the e-Progress File system.

Better results can be achieved by making real the rhetoric about making students partners in learning, and providing a student-oriented supportive learning environment within which to study. This applies to employability and academic achievement alike – both areas benefit equally.

Implementation

The online Progress File system (also known as the logbook) provides a way for students to make entries that are hidden from other students but visible to staff, who can view results by course, module, student or time. First years in particular are expected to make entries for each module at least weekly. There are two principal benefits. Firstly, students gradually learn to recognise what skills they are gaining and where and how they are gaining them, and to identify and tackle problems that occur. Secondly, through regularly reading the entries, staff get immediate feedback on their modules, enabling difficulties to be dealt with quickly, and get to know each student better.

This feedback is representative and inclusive, encouraging those who might not otherwise have the confidence to speak up to take part. Problems are resolved quickly, improving achievement and satisfaction. Staff also gain a very timely insight into the progress of their module and are able to address problems immediately.

Group discussion around maximising achievement is used to introduce PPDP so learners realise for themselves how it can contribute to their success. The system is adapted each year in response to student feedback and has been used successfully outside mathematics, and outside SHU.

During the 2016-17 academic session, 455 students from 5 courses have contributed 23,669 entries comprising almost 2.5 million words.

The e-Progress File system has a major impact in sustaining a professional academic community with students sharing their feelings candidly with staff who can provide a personal response, getting to know individuals more effectively.

"It helped strengthen the bond between teacher and student because it allows lecturers to understand more about what we want."

At the end of the year, students gain a great deal of confidence by reviewing their entries, recognising how far they've come and how much they've achieved. It seems to be human nature to value skills yet to be acquired over those already acquired, and this review helps students recognise the value of what they have achieved already and provide added confidence that they can continue to achieve more in the future.

Evidence and recommendations

Here are some examples from the student end of year reflection:

- "I have found this progress file very useful throughout the year, in helping me to record my thoughts and feelings on all the modules, I have also found it useful in helping me to organise my time better by finding where my weaknesses and strengths are so I am able to see where I need to concentrate most on."
- "I also think that the progress file has helped me to develop my communication skills and to become more confident in talking about my own work and feelings on the course. It also allows you to see for yourself how you have progressed, or dealt with any personal problems."
- "The online progress file has been a huge help in making the jump from being in a 6th form to university. It forces you, once a week, to actually think about what you have done and what you still need to do."
- "it was a way to express my feelings without thinking of what my teacher will think about me. I like this very much and makes me more strong because when a teacher send me an email as a reply of what I wrote in the logbook I fell that our teacher really care about our progress."

From the experiences at SHU, there are a number of important features that an e-PDP system should have in order for it to work effectively:

- a key staff champion is needed to take responsibility for developing the system, and for selling it to all participants;
- it needs to be very easy to use (both for staff and students);
- it needs the active engagement of staff – students clearly perceive the logbook as having more value if they receive prompt replies or feedback to their entries;
- although students understand the importance of developing employability skills, they prioritise their work according to credit received, so it is important that the logbook entries are assessed;
- the system needs to be embedded into the curriculum, becoming an important element of normal academic activity on the course;
- the process is more important than the tool used – student engagement is the key and PDP should not become a tick box activity.

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15. Valuing and fostering communication skills: a dispersed approach

Carol Calvert, School of Mathematics and Statistics, Open University.

Skills addressed: mathematical communication skills.

Context

The Open University context is unusual in that the majority of our students are already in work and are aged over 21 years. Our courses are typically either 30 or 60 credits and these can be slotted together, with considerable flexibility, to obtain a degree provided the required 120 credits have been achieved at each of Level 1, level 2 and Level 3, and the necessary pre-requisite knowledge and skills are acquired along the way. Level 1 roughly equates to first year Undergraduate study; level 2 to second year; and level 3 to final year undergraduate. Many of the mathematics and statistics modules are used for service teaching in other disciplines, especially at Level 1, to some extent at Level 2, and to a lesser extent at Level 3.

A recent survey of our alumni with a qualification in mathematics indicated that at the start of their OU study around 25% of the respondents had been "career changers", 25% "career developers", just 5% "career starters" and over 45% took the qualification for non-vocational reasons. This situation will have changed because the survey included certificate and diploma students as well as those studying for degrees. However, basically we still have a low proportion of "career starters" and hence our students have a different perspective on employment. Hence our identification and development of employability skills with students is perhaps atypical.

Mathematics modules are most commonly taken as a part of STEM degrees and for some students their study of mathematics is a relatively small part of their qualification and perhaps even a slight digression from their main subject. We had over 4,000 students taking level 1 mathematics modules in October 2016 and of these 10% were studying for our Open Degree programme. So the concept of a "named qualification" does not have universal relevance to all our students and individual courses (modules) remain the building block to qualifications. So we introduced a flexible system of supporting and developing employability skills and of helping students recognise what they are developing independently in the rest of their lives.

The summary impact of all this is that we have students with a wide range of transferable employability skills, obtained either in their work place, or through the process of organising, negotiating and self-motivating themselves through six years or more of part-time study. They may seriously under-estimate the importance of such skills to employers and the variation in skills between students is large. Hence we felt the type of stand-alone courses relating to employability skills that run at other HE institutions would not be appropriate for our students.

Implementation

Our approach has been to help students appreciate the importance of communication skills and has been three–fold: firstly through the modules, secondly through employer-led sessions about working in sectors using a mathematics degree, and finally through our dissemination of careers and employability information directly to students via their StudentHome webpage. The first set of work is led by our academic module teams, the second jointly with School staff and the University's careers service, and the third by the careers service and the library. We have a periodic audit process of to identify which skills are embedded in which modules across the University.

Modules at level 1 emphasise the need for clear and concise mathematical communication and marks in written tutor-marked assignments (TMAs) are specifically awarded for effective communication. Our 60-credit level 2 module in applied mathematics has a mathematical modelling project where students need to work together. Since the students do not have the luxury of meeting their co-workers they have to use emails, wikis and our synchronous meeting facility, OU live. Level 2 and Level 3 statistics modules contain assessments that require students to write and comment upon 'technical' reports. Our students are distance learners who are continually assessed, and hence their ability to extract key information from written materials and to provide concise, coherent and relevant answers to assignment questions is highly developed by the time they are looking for career moves. They are familiar with communicating in non-visual environments such as forums and online tutorials. But they may view these as usual skills and may not believe it is important to explicitly tell potential employers about them.

The School of Mathematics and Statistics arranges a day of face-to-face talks by employers, which are designed to highlight to students the types of skills employers typically look for. Unsurprisingly potential employers consistently comment on the need for good communication skills. These sessions are recorded and form the basis of subsequent online sessions with students on what employers are looking for when they recruit. This gives us a mechanism for students to hear from employers, rather than University staff, about the value placed on 'soft' skills.

Finally, there is the careers and employability section accessible to all students, which is divided into four sections:

- Personal Development Planning - includes tools to help students to identify and develop transferable skills in order to achieve their career goals;
- Careers Advisory Service – resources and advice from the OU Careers Service;
- Careers in Mathematics and Statistics – descriptions of how a mathematical qualification can be used, and includes information about the careers of some OU Alumni;
- Transferable Skills – a list of key employability skills developed through the study of mathematics and statistics.

A substantial barrier in this approach is the voluntary nature of the process and the emphasis on the student to explore these resources independently. This is necessary because so many of the students are already in employment, and are not explicitly studying for career enhancement purposes. However, the focus on independent study skills that our students are expected to develop means the major advantage of this approach is that students can make sensible choices about when and how they use the available resources, and tailor them to their own needs.

Evidence and recommendations

Around two hundred students attended the most recent careers day when employers talked about working in different sectors. Another thirty attended the subsequent online session accessing the same materials, but many others may have viewed the recordings of the employers' talks.

In terms of recommendations for the future we would like to increase the opportunities for students to verbally present their findings – from project or individual work. Group work is difficult to arrange for students but again this is an area we would wish to develop.

16. Recording small group interaction to encourage reflection on group work

Peter Rowlett, Department of Engineering and Mathematics, Sheffield Hallam University.

Skills addressed: group work, reflection.

Context

The BSc (Hons) Mathematics degree programme at Sheffield Hallam University has a strong employability thread, focused on skills that will assist students throughout their careers, developed alongside technical content. A description of this context is given in the paper by Jeff Waldock in this collection (case study 13).

This case study considers a session in the first year, compulsory Mathematical Modelling module. This aims to develop modelling and employability skills through applying mathematics to real world scenarios. The module makes use of group work to assist with these aims.

For the first few weeks of their first year, students worked in class in informal groups. Before the introduction of summative group work mid-way through term 1, a class session was run on working in groups. The principle is, based on the idea of Challis et al. (2002), that "it is not sufficient to put students into groups and ask them to undertake tasks" (p. 89). Instead, we try to explicitly teach students how to operate within groups.

Implementation

Students formed groups and were asked to complete a task called Zin Obelisk from Nrich (no date). The actual task used isn't especially important, so long as it is fairly quick to complete and requires the group to work collectively. The Zin Obelisk task asks students to answer a question using a set of 34 information cards. These contain information relevant to the building of a 'Zin' in "the ancient city of Atlantis". The goal is to determine on which day of the week the Obelisk was completed. The cards contain information such as the dimensions of the Obelisk (e.g. "The width of the Zin is ten feet"), how time is measured in Atlantis ("The working day has nine schlibs") and the rate at which work is completed ("Workers each lay 150 blocks per schlib"), as well as some irrelevant information ("Green has special religious significance on Mermaidday"). The task is only marginally mathematical, but sorting the cards and interpreting their meaning to solve the task is sufficient to occupy a small group for between 10 and 20 minutes and quickly exposes group dynamics.

Each group was asked to audio record their Zin Obelisk interaction and produce an outline transcript. I found students less hesitant to be recorded in 2016 than when I used the same task a few years ago, and no group needed equipment or instructions to be able to record themselves. The outline transcript format was based on a method I heard at a conference some years ago (Lowrie, 2011): one column per group member and using rows to indicate time (but not to scale). For each interaction, groups made a rough note of what was said and placed arrows between notes to indicate who responded to whom.

Following the production of 'transcripts', I spoke to the class about team roles and operation of group activities. While highlighting some flaws with it, I asked them to read the Belbin team roles (Belbin, 2011) as a model of understanding group interactions. All students were able to identify one or two roles that they took during the task. Speaking to groups helped this determination.

Evidence and recommendations

Students generally responded positively to the task. The following anonymised comments are taken from students' Progress Files (see case study 14):

- "This weeks session was very interesting, I really enjoyed working in the group I was in, and it was fascinating to record and play back what we come up with as a team."
- "We had to record ourselves completing this task so that we could listen back on this and make a script of what was said, and we reflected on how we worked on the puzzle, and our roles within the task. This was useful as it made me think about how I work within a group."
- "This weeks work was where we had to split into a group of 3, solve a modelling problem and record and evaluate our progress, I found this lecture useful as it made me realise what my strengths and weaknesses are during group work so I can work on my weaknesses for future reference."
- "I didn't think I was talking as much as the others during our project however, when we went through the recording and did a log i realised we were all talking roughly the same and contributing the same amount."
- "The whole recording session was slightly uncomfortable to begin with, but I came around to it, I completely forgot that we were recording for large periods of the recording."

One problem is that a group that completes the task quickly has less to 'transcribe', so it is useful to have something else for students to do if they finish early.

It is important to try to emphasise to students that the Belbin roles are not fixed and predestined. One student wrote in the Progress File that the session was undertaken "so we all knew what kind of person we are". There is a finality to this statement, while in reality the activity only really helps them reflect on how they worked within *this* group task. People act differently in different circumstances, and can be encouraged to challenge themselves to behave differently if they desire.

The information on group make up can be used when assigning students to groups, for example I used this to gain information on students when pairing up self-chosen groups to form partly-chosen, partly-not-chosen groups (advantageous because students don't like working without people they know, but working with people they didn't choose is more realistic). For further details of this, see Rowlett (2013).

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17. Formative assessment in first-year mathematics for engineers

Jonathan Cole and Karen Fraser, School of Mechanical and Aerospace Engineering, Queen's University Belfast.

Skills addressed: self-assessment, peer assessment, reflective learning, confidence.

Context

The mathematics module for first-year aerospace, mechanical and product design engineering students is taught over 24 weeks with three hours of class time per week. The first half of the syllabus is mainly a repetition of A-level topics (logarithms, polynomial equations, trigonometry, complex numbers, differentiation and integration), while the second half covers matrices, differential equations, vectors, Laplace transforms and statistics. The class typically has about 170 students, most of whom have entered university directly from school. A large majority (~90%) of them have achieved at least grade B in A-level Mathematics, but the cohort usually includes a small group of students with alternative qualifications in maths. The diverse nature of the cohort is emphasised by a few students with A-level Further Mathematics (about 5% of the total).

The assessment of the module has been redesigned for 2016/17 with the aim of building students' confidence by encouraging them to take greater responsibility for their learning with the use of self and peer assessment and through evaluation and reflection on the quality of their work and learning.

Reflection has a key role in employability – not only does it influence meaningful learning, but it also helps develop important aspects of learning behaviour (Moon, 2004). Self-confidence, in dealing with challenges, and self-awareness, in terms of being able to recognise and articulate strengths and weaknesses, are important skills for employability and they can be developed by reflective practice. Peer assessment should also contribute to developing employability skills (Cassidy, 2006) since it requires students to think about the criteria used to evaluate work and make judgements (Falchikov and Goldfinch, 2000). Chickering and Gamson's (1987) seven principles of good practice in undergraduate education emphasise time on task, cooperation among students and prompt feedback as beneficial to learning. Academic learning time has to do with quality; it is the amount of time students spend actively working on tasks of appropriate difficulty. These ideas have helped shape the learning and assessment approach in the first-year maths module to promote both a deeper understanding of the mathematical skills required by engineers and the important employability skills mentioned above.

Implementation

A formal teaching style is generally employed in lectures (two hours per week) with numerous worked examples and typical engineering applications. The redesigned assessment strategy is focused on the feedback session (one hour per week).

Students keep a log book for the duration of the module. They are expected to complete a weekly worksheet, based on that week's lecture topic, in their log book before the next week's feedback session. This ensures engagement with tasks on a weekly basis. It is low risk for students: if they find the tasks easy, they benefit from teaching others and learning to give feedback on their peers' work; if they find the work more challenging, they can receive help both before the class (through a maths drop-in service and peer mentor scheme) and during it. They work in groups of four in the feedback sessions and it is emphasised that this is a community, not a competition. A postgraduate student works through the solutions on the screen and students mark each other's work. Thus, feedback is

provided weekly (frequency) in the feedback session from other students and while they still remember what they were doing (timely). Students have to write a reflective paragraph after each feedback session to include a self-assessment and comments on how they have addressed feedback from others and how they have helped others. Log books are submitted at two intermediate points for review by staff and are submitted at the end of the module for marking (50% of module mark).

Attending at least 75% of feedback sessions is necessary to pass the module. The process aims to encourage deep learning and should ensure that students are very well prepared for the exam (50% of module mark).

Evidence and recommendations

With the new assessment approach having been implemented just this year, it is too early to evaluate its impact on exam performance. However, there is encouraging evidence from observation of the feedback sessions and review of log books. Benefits noted by students included being better organised and learning through explaining. Student comments on mid-module questionnaires referred to both subject knowledge and generic skills:

- "Opportunity to see other people's methods and working."
- "Shows me different ways to do questions, increasing my understanding of the concepts."
- "All working is kept in one place and that allows me to track my progress."
- "Feedback and reflection has been useful as it has encouraged me to review my work after class hours."
- "Makes each student want to improve each week."
- "Keeps work well organised and up to date."
- "Motivates me to get the work done."

There are challenges associated with allocating students to groups. This was based on prior mathematical achievement; students with lower qualifications were mixed with those with higher A-level grades to maximise learning opportunities. However, due to the academic background of the class, this left some groups containing all grade A students. Some students were concerned that the feedback sessions were not efficient, especially when all members of the group have the correct answer to a question. Some felt that leaving feedback on correct answers was a waste of time, but this is not necessarily correct as there is opportunity to check for more concise methods. Only the difficult questions should be covered in class to minimise time wasted. Detailed solutions to all the questions on the worksheets are provided on the intranet after the feedback sessions to enable students to review their work further in their own time. This is important since there is time to review only a selection of questions in the feedback session. Other student concerns included the difficulty in giving feedback on correct answers, difficulty in giving a variety of feedback, and whether the feedback is appropriate or helpful to others.

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18. Setting open-ended work to develop confidence

Peter Rowlett, Department of Engineering and Mathematics, Sheffield Hallam University.

Skills addressed: confidence, self-efficacy.

Context

The BSc (Hons) Mathematics degree programme at Sheffield Hallam University has a strong employability thread, focused on skills that will assist students throughout their careers, developed alongside technical content. A description of this context is given in the paper by Jeff Waldock in this collection (case study 13).

This case study relates to a second year, compulsory Mathematical Modelling module. This runs as a series of half-semester case studies, each in different areas of applications, aiming to develop modelling and employability skills. The module also contains teaching and assessment around explicit career management skills and reflection. This case study is about one of the modelling case studies, which also addresses module learning outcomes around group work. I ran a group project on a topic similar to this at Keele in 2012 (see Rowlett and Russell, 2016).

Implementation

During the 2016 Olympics and Paralymics, I had a script running that collected public tweets (100 per minute) and saved these to a database. For the Olympics (search term 'olympics OR #olympics2016 OR Rio2016' from 3rd-23rd August 2016), I have around 3 million tweets, and for the Paralympics ('paralympics OR #paralympics2016 OR #Rio2016' from 31st August-3rd October), I have 1.8 million tweets saved. This is deliberately configured to be too much data to simply load into Excel (versions of Excel since 2007 have a maximum of $2^{20} = 1{,}048{,}576$ rows), so the data cannot simply be loaded into Excel. Using Access was suggested, but not required. It may seem like a lot of data, but Twitter claims "over 187 Million Tweets were sent about the Games" (Filadelfo, 2016), so actually it is a small fraction.

The implementation is such that it contains flaws. For example, tweets about the Games that do not include the search terms were not recorded. In minutes of low activity, it may be that all tweets were recorded, but the limit of 100 tweets was frequently reached during popular times.

Data included information about the tweet (date, text of the tweet, details of hashtags and mentions of other users, location) and about the user who sent it (username, name, location, number of followers, how long they have been a user, their timezone). The text recorded is free-form and will contain positive and negative sentiments, references to sports, countries, medals, people, brands, events, etc.

For the summative work, groups were asked to set their own research question to answer using the dataset. They were told they may use any area of mathematics they choose, which could include but was not limited to statistics, language processing, OR, graph theory, algorithm design and computational methods. Some suggestions that were included in the coursework brief: use all or part of the data; propose a model of social media behaviour and use the data to validate it; concentrate on the Olympics, Paralympics, or both; ignore the Games completely and just treat this as a collection of social media data; compare the saved data with other samples of text they collect; develop an algorithm to extract some meaning (perhaps sentiment) from tweets. Groups were encouraged to choose a question that was not so closed that it could be answered quickly, but not so open that it couldn't really be meaningfully attempted. They were required to agree their question with module staff before attempting it in order to allow some control over this.

The focus, for me, is more on whether students can set a research question and attempt a problem they are not told how to solve, than whether they succeed in answering their question. If they didn't succeed, they were encouraged to explain what they tried, why they thought it was a good idea and why it didn't work, and were not penalised for the lack of success.

Students were told that since they had defined the question and decided the area of maths, stats or OR they would use, that they would not get detailed help on these technical aspects from module staff. Tutor attention was focused on helping groups operate as groups, as well as some technical aspects of extracting data from the data set.

Evidence and recommendations

This is an unusual assignment in our degree programme, in that neither the goal nor the methods to be used are clear.

The initial reaction of students to such a vague brief in a piece of work that they initially feel ill-equipped to handle can be anxiety. We do not often ask students to define their own coursework or work with limited technical guidance. However, I believe it is useful for students to be given the opportunity to set the direction of a piece of work and practice their ability to tackle open-ended work, and good for self-efficacy to see their expertise being useful to answer a question they defined (so hopefully are interested in).

This piece of work is fairly low-stakes (in terms of the overall degree), so it is a good opportunity for students to try something they are not initially comfortable with.

There is an issue of technical expertise in handling such a large data set. However, I have now run this project with over 50 groups of undergraduates and believe it is possible to rely on someone within most groups having sufficient willingness to engage with software to be able to cope with the demands of this task.

One advantage of students attempting a relatively low-stakes open-ended piece of work is that it provides preparation for the compulsory individual final year project.

Students were initially apprehensive about approaching an ill-defined task (comments from Progress Files, see case study 14):

- "I do feel that the task set is very vague and this has made choosing a topic difficult. Likewise, we have never used Access and therefore it makes working with the data hard as I have no idea of how to filter it."
- "In our groups we have to analyse the data set given and come up with a question which we can answer. I feel like this will be complicated in parts as there isn't much direction given to us in what we can do."

However, once they engaged with the project they generally became more positive, and ultimately performed well:

- "Although I was initially apprehensive about not having a set assignment question to work on, after meeting with my group I feel slightly more confident that we be able to work together to deliver a good piece of work."
- "I am new to Access but have understood it quickly, and so I believe this will be my job to sort and filter the data, in any way we need to to obtain results."
- "The data set looked confusing to begin with, however, as we started working on it, we were able to gain a better understanding of it."

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