Developing Graduate Skills in HE Mathematics Programmes

Case Studies of Successful Practice

September 2010
Embedding Graduate Skills in Mathematics Programmes - Case Studies

Introduction

The increasing importance attached to the additional skills students should be gaining at University, over and above their course-specific skills, has been emphasised in recent reports both by the Government (e.g. ‘Higher Ambitions’, November 2009; 'Unleashing Aspiration', January 2010):

“All universities should be expected to demonstrate how their institution prepares its students for employment, including through training in modern workplace skills such as team working, business awareness, and communication skills"

"Universities should develop proposals to integrate a flexible element of professional experience into all higher education courses"

by students (National Student Forum Annual Report, October 2009):

"[Universities should] increase resources for, and promote the use of, personal development plans, and provide optional modules/classes that consider how the skills and knowledge are developed"

and by employers (‘A Manifesto for Graduate Recruitment’, March 2010). This applies to postgraduate courses as well as undergraduate courses (Smith Report, ‘One Step Beyond’. March 2010).

There is clearly pressure from all quarters to develop courses that more effectively prepare graduates for employment, and raise student awareness of the range and importance of the skills that they need. All the indications are that this will continue for at least the next ten years. Mathematics graduates, as much as any, will be affected because of the diverse range of career opportunities available to them.

There are significant barriers involved, however, when seeking to modify Mathematics programmes to encourage the development of graduate skills. One is fundamentally philosophical, as some will wish to retain the pure, theoretical nature of their courses. Another is the practical difficulty of finding space for graduate skill development in a crowded curriculum.

This latter problem can be addressed – at least in part - by developing different approaches toward learning, teaching and assessment, and by encouraging student 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. The introduction of the Higher Education Achievement Record, as recommended by the Burgess Report, will provide further incentive for this.

A series of short case studies are being developed, each focussed on specific graduate skills, providing examples of ways in which these have been successfully developed. The project was commissioned from the National HE STEM Programme Mathematical Sciences Strand through the MSOR Network, and also aims to evaluate what techniques have been successful and why, and to make some suggestions for how they may be used elsewhere.

For more information, go to http://maths.shu.ac.uk/msor/graduateskills/. Please consider adding your own case study by downloading the template and emailing it to: j.wallock@shu.ac.uk .

September, 2010
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**Context:** The Careers Service at the University of Manchester has long been recognised as one of best in the country, voted top careers service for five consecutive years by the Association of Graduate Recruiters [1]. However too many of our students leave their career planning until late in their programme or after graduation. To encourage our students to engage with the Careers Service earlier and to make sure they are aware of the range of careers open to maths graduates we have initiated a series of maths dedicated career events called 'Calculating Careers' based in the School of Mathematics.

In September 2009 we asked our new mathematics undergraduates whether they had a specific career in mind when they graduate. Out of the 296 responses, 197 (67%) answered 'no'. Of course, at this stage in their education this need not be a cause for concern and in fact one of the attractions of studying a mathematics degree is that it leaves career options fairly open. However the results highlight the fact that our students need effective support and advice throughout their programme to help them to find rewarding and interesting careers when they graduate.

One of the main messages to convey is that, when it comes to career planning, it pays to start early. In the first year, we should help students to develop their CVs and find out about their career options. There are opportunities for gaining useful experience such as the spring weeks offered by many of the large financial institutions.

During their second year, students should be encouraged to apply for internships and other work experience. Employers are increasingly using internships as a recruitment tool and even if a student is not offered a job with the same company, the experience will strengthen their CV. Internships are competitive but, even if unsuccessful, a student will benefit from the experience of filling in application forms and focusing on their strengths and weaknesses.

Applications to graduate employment schemes start early and students need to be well-prepared by the start of their final year. However students should be aware that there are other options available, not just with large companies. Small and medium sized enterprises will consider students with 2:2 or 3rd class degrees if they have other qualities and skills to offer.

**Implementation** (including barriers and enablers):

To help our students with career management we have instigated a series of maths specific careers events under the banner 'Calculating Careers'. The main annual event is a Careers Fair for mathematics undergraduates and postgraduates held in the School of Mathematics. This has run in October 2008 and 2009 and has attracted over 20 graduate employers and over 250 students each year. The employers included banks, actuarial and insurance firms, the civil service, engineering, energy and retail companies. They were selected as known recruiters of mathematics graduates and many have offices in Manchester or the North West. Several of the representatives on the company stands were recent graduates from the School. As well as a chance to talk to company representatives, there were themed panel sessions where students could question experts about careers in finance, technology and teaching. Careers advisors were on hand to give practical advice on CVs and applications.

Before the fairs we ran information sessions to help students prepare for the event, and a detailed brochure with employer profiles and advice on how to make the most of the event was circulated.
Throughout the academic year we run follow up events such as applications and CV workshops, talks on teaching mathematics and careers for statisticians and visits to the School by employers and training agencies. A recent event for final year students gave advice on what to do after graduating such as the Manchester Graduate Internship Programme and other graduate recruitment events [2].

The School has developed a Careers Wiki [3] with specific information for maths students, including profiles of graduate employers, examples of careers, careers events of interest to our students and general advice on job hunting, applications and CVs, online tests and assessment centres, interviews and internships. Recent graduates from the School write about their job hunting experiences and career choices.

To complement the Calculating Careers activities we have written an Employability Skills guide. This gives practical advice on developing skills by choosing particular course options and participating in useful extra-curricular activities. The guide has a suggested 'career timeline' so that students can plan their career management from the start of their programme. It also includes advice from a recent graduate on the skills and knowledge that they find useful in their current job as an Actuary.

The challenge is to make sure that all our students are actively engaging in planning their career or further study after graduating. We intend to integrate career planning and skills development into our personal tutoring system. The employability guide will be used as a focus for review meetings between the students and their personal tutors in the coming academic year. A training and information session by the Careers Service is being organised for staff in the School to help personal tutors support their students' personal development. Academics should not be expected to offer careers advice but should know where to direct a student for help with career planning and skills development.

Evidence and recommendations:

The interest from employers in our Calculating Careers events has been positive and we have had no difficulty finding representatives from a range of sectors. The 450 students attending the 2008 Fair were asked to fill in an evaluation form. Over 80% of the respondents were happy with the sectors represented and over 90% thought it was worthwhile attending. The main reasons for attending were to seek careers advice and intern opportunities, with 43% of the respondents saying the employers represented had good graduate and intern opportunities. For 51% of the students, this was the first careers event they had attended. Holding a maths specific event in the School may have encouraged students to find out about careers at an earlier stage than they would have otherwise.

It is too early to tell whether our Calculating Careers initiative has made a difference to students' employability. The Destinations of Leavers from Higher Education [4] currently has information on employment gathered in November 2008. The survey asks graduates about their status six months and three and a half years after they graduate, in particular what percentage are in 'graduate' jobs. This information is listed on the Unistats website [5]. Of course, recent economic events have had a major effect on graduate recruitment and so this may cancel out any positive action. However anecdotal evidence suggests that our efforts have been greatly appreciated by our current students who need all the help they can get in a competitive jobs market.

References / more information:

1. http://www.agr.org.uk/
2. http://www.careers.manchester.ac.uk/
3. http://www.maths.manchester.ac.uk/~bl/careerswiki/Main/CalculatingCareers
5. http://unistats.direct.gov.uk/
Institution: Oxford Brookes University
Department: School of Technology
Name: Mary McAlinden
Title / Scheme: Personal Development Planning
Skills Addressed: Reflection, self-awareness, action-planning, communication

Context:
The QAA Progress Files guidelines define personal development planning (PDP) as: “a structured and supported process undertaken by an individual to reflect upon their own learning, performance and / or achievement and to plan for their personal, educational and career development”. Students in HE may experience PDP in a variety of different ways. For example, they may meet it as an add-on to their academic studies and be given access to tools for recording their personal achievement which may be accompanied by other forms of support and advice. Alternatively, they may find it more closely integrated into their core course studies. In Mathematics, the explicit inclusion of PDP within the curriculum can encourage self-reflection and assist students to improve and develop their skills for employability in a structured way, at the same time as they are extending their knowledge and understanding of the subject.

Implementation (including barriers and enablers):
Since September 2005 a strand of PDP has been incorporated into a final year Mathematics module at Oxford Brookes University. The module carries 30 credits, runs throughout the year and is on offer to all students on the specialist programmes in Mathematics and Mathematical Sciences. The PDP strand of the module carries 10% of the total marks and has an allocated member of staff but has no dedicated timetabled teaching slot.

The key emphasis in the PDP strand of the module is on careers preparation and self-awareness of transferable skills development. Students follow a structured PDP programme, the constituents of which have varied with experience in using the scheme and in response to student feedback. In the most recent run of the module the programme included seminars on CV preparation, interview techniques and library and information resources. Students were also required to give a presentation on a mathematical topic and share peer-feedback in a small group setting. In addition, they undertook an action planning exercise, produced a log of how their transferable skills developed during the academic year and had to write a series of short reflective statements.

Students submit two short PDP logbooks for assessment. The contents of these logbooks are specified in detail and a template is provided. This includes forms for providing evidence of attending the various sessions, grids for keeping records of feedback and skills development and space for writing reflective statements. All components of the PDP programme carry a small assessment weighting and are categorised broadly as either activities to be completed or reflective written work. Students are awarded full marks for completing an activity exactly as specified and their written work is graded using a published assessment matrix.

The assessment scheme is designed in such a way that failure to participate in an activity will have a knock-on effect on the student’s ability to write the corresponding reflective statement and hence result in a more substantial penalty.

Midway through the year, following the first assessment point, students receive formative feedback on their work via an interview. This provides scope for a one-to-one discussion of
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the student’s career plans and their awareness of skills development. It also provides an excellent opportunity to challenge students to extend the domain of their skills and personal development beyond curriculum boundaries and openly encourages greater use of personal initiative. For this purpose the discussion of a student’s prepared action plan can be an invaluable starting point.

The content and assessment of the PDP programme described differ substantially from what students expect in a Mathematics module. This is one of the challenges in implementing the programme. Students need to understand the relevance of their PDP work and a realistic amount of academic credit needs to be available to rewards their efforts. Experience suggests that this provides the initial incentive for engagement with the scheme and that a deeper understanding of its value evolves over time. For the programme to work effectively, in parallel with the mathematical content of the module, great care is needed to ensure that the assessment is kept to a manageable level for students.

From a staff perspective, one of the greatest barriers is in running the programme without a dedicated timetabled teaching slot. As the module includes students from a range of combined (or joint) honours degree programmes, significant scheduling difficulties can arise when attempting to arrange seminars outside class time.

Evidence and recommendations:

An evaluation of the PDP programme takes place at the end of the module when students are asked to provide formal feedback on their experiences. Further insightful information can be gleaned from the work submitted for assessment purposes. From this collective feedback it can be established that the activities to which students respond most positively are those which they perceive as both relevant and timely. For example, a time-management exercise does not work well with third year students and preparation for interviews is most well received when it takes place in the run-up to an actual interview. It is therefore essential that student feedback is used to inform the development of the programme.

Experience has shown that it cannot be assumed that Mathematics students automatically understand what a piece of reflective writing entails. While written guidance certainly has its value, in many cases students require more assistance than this. One way in which this can be achieved is through the detailed structuring of the PDP programme. For example, requiring students to log their transferable skills development and then write a reflective statement about their skills can produce a much greater reflective response than when they only have to write the statement. Students also need to be able to ask questions about the process and more specifically about how it applies to them as individuals. The involvement of a dedicated member of staff is therefore crucial.

Some students have identified that one of the benefits of PDP is the requirement to think more about careers. Explicitly including PDP in a module provides a structured framework for directing students to focus on this area. It can also assist them in acquiring greater self-awareness and actively encourages the development of their skills for employability.

References / more information:


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**Context:**
In 2006 Coventry University restructured the undergraduate curriculum framework to provide students with a choice of 150 compulsory half modules, Add+Vantage modules, each of which has embedded employability competency skills. This is complemented by a compulsory skills half module in the first and second year of all mathematics courses, with the passing of these modules a prerequisite for progression. Different members of the Department are involved with the teaching and all see the modules as an important part of our programmes.

**Implementation (including barriers and enablers):**
In the first year the compulsory half module of Academic and Professional Training is for all students on mathematically related courses, and is taught for 11 two hour sessions spread over two terms, in a room with PCs. The module leader has some commercial experience and the content covers:

- **Personal skills:** Study skills, Reflection on individual learning needs, Time management.
- **Career skills:** writing a CV; creating a Personal Development Portfolio.
- **Academic skills:** Use of the Library portal and subject specific databases; Referencing.
- **Professional skills:** use of Microsoft Word, Outlook, Excel and PowerPoint, File management. Introduction to LATeX
- **Working effectively as a member of a group; written and oral presentations.**

With the introduction of Activity Led Learning much of the teaching in the first half of this module revolves around the conduct of a small scale sample survey looking at the student experience of Induction week, or some other topic. This covers questionnaire design, sampling theory, collecting data from approximately 700 students from across all Faculties, analysing it in Excel, drawing effective charts and tables in Excel, and presenting the findings using PowerPoint. Teaching is focussed on each of these aspects, with time at PCs for students to put it in to practice for themselves using the data they had collected. Much of the student work is done in small groups which may change each week in the early part of the module.

Use is made of other professional staff from the Careers Service and the Library to deliver their specialist advice, and another member of the mathematics staff teaches LATeX. Assessment is through an oral presentation (10%); group work (25%) analysing and presenting in PowerPoint the survey findings; and the presentation of an online personal development portfolio which includes evidence of each week’s activities (65%).

In the second year module we cover:

- **Academic Skills:** library skills, referencing, use of SPSS,
- **Professional skills:** Project management, CPA, Gantt charts; written and oral
presentations;

- Writing of a report to professional standards.
- Personal skills: Writing application letters and a CV; researching placements;
- Maintenance of a Personal Development Portfolio showing reflection, self evaluation and evidence of personal development over the preceding year.

Again this is taught for 11 two hour sessions spread over two terms, using the same rooms as the first year module, which is a saving in timetabling. Use is made of other professional staff from the Careers Service and the Library to deliver their specialist advice. Assessment is by a written test in critical path analysis and Gantt charts (20%), a written report (40%) and a personal development portfolio (40%), which included research on a possible placement, a letter of application, and a CV.

Despite the Department seeing these modules as an integral part of our courses, the biggest challenge is to get every student to take this type of work seriously, and to make it as relevant as possible to mathematics and the final year project as well as providing general employability skills. The many who did see its relevance particularly appreciated the work on CVs, on presentations and on learning LaTeX.

In the second year the most difficult topic to teach effectively is writing a good report, which this year was put into practice with reports on “Professional and Academic Skills”. In both years the giving of timely and useful feedback on the portfolios is extremely time consuming and needs to be re-visted.

Evidence and recommendations:
Evaluation forms are completed at the end of the modules, students being asked to comment on what they felt were the good and bad points of the scheme.
Specific responses include:
- “Built up my self confidence, and I am now more comfortable speaking in front of people”
- “a great opportunity to improve on my group working skills”
- “Effective learning”,
- “Helps improve employability skills.”
- “I feel this module has helped me develop skills and learn things that to be honest I didn’t think I would learn at University, however I think these skills are useful.”

Benefits for the students include:
- The opportunity at an early stage of their course to work in different small groups on practical activities, helping with social integration of the cohort across courses.
- Early access to professional staff from Careers and the Library service.
- Gradual acquiring of skills necessary for undertaking a project in the final year.
- As early a start as possible to thinking about a future job, and thinking about the skills that might be picked up at University, as well as a degree, to help achieve that aim.

Benefits for the University include:
- Producing students as well equipped as possible for life after a first degree.
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Institution: University of Nottingham
Department: School of Mathematical Sciences
Name: Stephen Hibberd
Title / Scheme: Integrative use of group projects in Mathematics
Skills Addressed: Subject-specific, problem solving, team working, communication

Context:
Skills development within an HE degree is emerging as a high-priority area and explicit recognition of the importance of harmonising skills development within undergraduate degree programmes, as expected by QAA qualifications, include:
- apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding, and to initiate and carry out projects;
- communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
- the qualities and transferable skills necessary for employment ...

Including extensive skill-based outcomes within traditional mathematics degrees remains a challenge that can be enabled by project-based activities and used to extend student understanding and their application of knowledge gained from traditional lecture-based methods. Wider use of group project activities can further provide significant pedagogic and efficiency advantages within wider skills development modules.

Implementation (including barriers and enablers):
Vocational Mathematics is a synoptic module available to third year Mathematics students bringing together the subject-specific knowledge and mathematical skills attained in initial years of a mathematics degree in tandem with developing the wider skills expected for graduate careers or higher degrees. Development workshops and group activities give students awareness and exposure to relevant skills; extended group projects promote attainment of a wide range of skills. Skills addressed include organisation and delegation, project management, team working, together with more subject-specific skills of addressing more substantial unseen problems and open-ended analysis to demanding deadlines. Tasks require background research, selecting and applying mathematical techniques to obtain results and integrating the use of mathematical and presentational software for ultimately communicating quantitative ideas orally and in compact reports. Students experience an emphasis on:
- working collectively in a non-lecture environment;
- problem solving with a variety of directions and approaches;
- applying previously acquired mathematical techniques and their communication;
- experiencing first-hand applications of team skills.

Pedagogic advantages include
- students can learn from each other;
- group project activities increases the scope of projects and outcomes to a high level;
- students experience teamwork on a substantial level, self/peer evaluation and detailed feedback.

Group and Team skills: Experiencing the requirement to deliver in a tight timeframe in unfamiliar tasks and recognition of different group approaches makes students more receptive to understanding the concepts of group skills. An awareness of characteristics of teams is crucial to its effectiveness. Members can contribute in drawing on their technical knowledge but also have a potentially valuable team-role to perform.

Graduate skills: We explore the rationale for employing graduates. What are the general attributes and specific skills expected by potential employers from (mathematics) graduates? In practice, the
students are dealing with their perceptions and are generally unaware of the skills they attain from a Maths Programme.

**Project skills:** Importantly, the module is strongly rooted in mathematical modelling, i.e. *how to apply mathematics* and *how to communicate findings*. Elements of modelling are included within earlier core modules but ‘Voc Maths’ enables greater exploration of competing models or wider evaluation. Obtaining, assessing and researching relevant background information is an essential part of any study. During the module students will need to access a variety of information technology resources to help with mathematical computations and also to word-process project reports and to prepare and display materials for oral presentations. Training support for students is provided and student (group) presentations are videod for each project oral report and made available to student groups and used for feedback.

**Evidence and recommendations:**

At the start of the module a detailed skill survey based on student’s intake perception of skills is conducted and this is repeated at the end of module to give a profile of skills changes. These show generally an increase in perceived skills and also realisations to students of their own capabilities, strengths and weaknesses. Student feedback is excellent; a recent response highlighting our ideal:

“The best thing about this module is the skills that this module allows students to develop, many of which could not be developed in any other module. I feel that in terms of employability, this module had more value than any other course that I took; with report writing, teamwork and presentation skills being so key to so many careers and yet such a weak focus on these skills in any typical mathematics degree, I would say that any student would benefit from taking G13VOC. If this module was compulsory for all mathematicians, the quality of graduates would be greatly improved”.

Student feedback to School Evaluation of Modules (2010)

Project activities are widely identified as a valuable component of a mathematics degree programme but often restricted by concerns over implementation issues such as management, organisation and provision of project activities, training in skills, assessment, plagiarism, feedback, staffing, etc. Concerns seem intensified within group project activities, however the potential for enhancement of skills, peer learning and assessment are considerable together with greater efficiency on staff resources.

Vocational Mathematics was unique within the mathematics programme at Nottingham as an entirely group-project based and assessed through group project activities. Support from the School and modest financial support from the University to help frame workshops and develop projects enabled the module to be initiated. The initial restricted target cohort is now extended as an optional all final year BSc students and an extended version of this module is available to some MSc programmes prior to an extensive dissertation.

**References / more information:**


**Context:** The Venture Matrix is a University-wide learning scheme providing students with a chance to simulate the business world as an accredited part of their course. It is designed to encourage an entrepreneurial spirit, helping improve skills for employment.

The Venture Matrix extends the concept of enterprise education beyond the familiar tools of ghost companies and virtual business simulations by enabling students to form their own businesses, social enterprises and other ventures and to trade with each other in person in a safe, mentored environment. This helps them to gain realistic work experience and develop some important skills that they might otherwise find hard to gain in their programme of study.

The VM scheme was developed to address vocational education at HE level, particularly in response to governmental policy of widening participation, the emergence of enterprise education as an integral part of the curriculum, and the role of employers in HE.

Since students from each level and from a variety of courses are involved in the Venture Matrix, those who take part can work in a variety of roles in an interdisciplinary context - great experience and preparation for graduate employment.

More information is available at: [http://venturematrix.shu.ac.uk](http://venturematrix.shu.ac.uk).

**Implementation (including barriers and enablers):**

One of the modules in the Mathematics programme at SHU provides an ideal opportunity for engagement with the Venture Matrix scheme. The module is called 'Mathematical Programming for Excel and the Web' and, as the title suggests, is intended to develop skills in creating mathematical applications delivered via a spreadsheet and over the internet. During the first half of semester 1, students develop specific programming skills in Excel. In the second half they put these into practice through individual projects - chosen from a list offered by the tutor. The pattern is repeated in semester 2, with web programming in Javascript and PHP.

It is in the project parts of the module that participation in the Venture Matrix is possible, and it was decided to try running a pilot study to see how successful engagement between the Maths programme and the VM could be. Therefore, during the second semester of the past academic year (2009-10), students taking this module were offered the opportunity to take part in a particular venture as an alternative to one of the existing project choices.

The venture in question was from a group of three Business Studies students who had created a venture called 'Employability Boosters'. They wanted to create an interactive quiz that could assess an individual’s mathematical/numeracy skills - and needed partners who could create and implement the quiz. The BS students would be principally involved in creating the look and feel of the interface, and choosing the style and nature of delivery of the questions; the Maths students would devise the questions themselves and create and implement the quiz.
The project was necessarily different in nature from those normally offered in a number of ways:

- It would be a group project (involving up to three students) rather than an individual one
- This team would, in addition to the creating the product itself, have to engage in negotiation with the BS students to determine the specification and requirements for the product, and to liaise with them as the project progressed. Some degree of project planning and organisation would also be required.
- The assessment of this project would have to take account of the different nature of the project, and yet be equitable. Students are expected to write a report of the project, including a critical reflection of the outcome. In this case the students were asked to also write an account of their personal contribution to the overall project.

In the event, one group of three students wanted to try this project, and following a briefing by the tutor, were put in contact with the Employability Boosters team. They were advised to keep close records of all meetings that took place to discuss the progress of the project. Apart from maintaining an oversight, and offering technical support when necessary, no further tutor involvement was necessary.

**Evidence and recommendations:**

In their evaluation of the project, the Maths students reported that:

"The experience of working with the Employability Boosters has been a great chance to build our team and communication skills, whilst working within a professional environment. This project is definitely something that should be repeated, but only if the groups involved are willing to put a lot of time and effort into the scheme, with a shorter time frame. A lot of our work on this project took place whilst finishing the teaching section of the web programming. Thus we were still learning whilst we were creating the site. Many people had not started this project until we were nearing the finishing stages so they need to be informed of the workload. However, the workload is balanced out by the crucial skills you are developing whilst working with the final years; communication being the main in my opinion."

Comments from the Business Studies partners:

- "Regular progress meetings [with the Maths students] were conducted in a professional manner with extremely good communication displayed between the groups.
- The [Maths students] showed good initiative and strong team skills.
- They were good at articulating the requirements of "non-technical" people and solving the problems through innovative design techniques.
- They showed great passion and determination to help with our real-life project. To conclude, they couldn’t have been more supportive in helping us and we are extremely grateful for this. We are delighted of the outcome and the group have met all of our key requirements efficiently and effectively."

The outcome was extremely successful - as evidenced by comments in the next section. It is clear that a major factor in this success is the fact that the group of students were very hard working, motivated and able. Some degree of selection is necessary when allocating projects of this kind, otherwise an acceptable finished product may not be achieved in the time available.

**References / more information:**

The finished project is available at [http://maths.shu.ac.uk/students/webster_clare/EmployabilityBoosters/](http://maths.shu.ac.uk/students/webster_clare/EmployabilityBoosters/)

Username: 'employability', password: 'boosters'
Institution: Sheffield Hallam University  
Department: Engineering and Mathematics  
Name: Jeff Waldock  
Title / Scheme: Peer Assisted Learning  
Skills Addressed: Teamwork; Autonomy; Leadership; Communication; Presentation skills

Context: 
There are many types of Peer Assisted Learning schemes found across the HE sector, and most can be classified into two types – individual and group. The former involves more experienced students being paired individually with one or more less experienced students in an informal mentor/mentee partnership. In the latter case PAL leaders provide support in a one-to-many group-based setting. This may be in the form of informal drop-in help sessions, where any first year student who feels they need help can meet the PAL leader. A number of such schemes in Mathematics at UK HEIs are in existence, some of which are identified in the reference list. A less common variant is where PAL leaders are assigned a small group of first year students, meeting at regular timetabled sessions to carry out specific activities. This is the model adopted at SHU.

Implementation (including barriers and enablers):
The scheme in the Mathematics programme at SHU involves a final year students acting as PAL leaders for groups of first year students throughout the first semester. In the current academic session (2009-10) there are 12 final year students each of whom facilitates a group of 7 or 8 first years who are working on small projects as part of one of their modules. Each group has to identify their own project topic, and organise themselves effectively. PAL leaders encourage the groups to undertake a Belbin-style group role indicator test to help them identify appropriate roles. At the end of the semester, each group has to deliver a poster, an oral presentation and a written report – these form the basis for their assessment of this element of the host module.

The project is not intended to be especially challenging mathematically to the first year students - the idea is for them to make use of existing technical skills, and develop their teamwork, research, leadership and communication abilities.

The PAL Leader does not teach the first year students, but encourages them to recognise for themselves what they need to do - which of their group is best suited to which task, for example, and how they should make progress. It may involve asking searching questions of the group in meetings, guiding discussion or taking note of who is not contributing and finding ways of helping them get more involved. PAL leaders are provided with one day's training before the start of the semester to help raise awareness of these issues, and provide them with some practical suggestions.

The member of academic staff allocated to each group provides support to the PAL leader, and maintains overall responsibility for the smooth running of the sessions. Some choose to take an active part in the weekly sessions while others allow the PAL leaders to lead them.

Difficulties in setting up and running the scheme include the need for at least one person to champion the cause, devoting time and energy to motivate the participants and to stimulate enthusiasm for it. A lack of resource – principally staff time – will also inevitably be a major barrier to success.
It is very helpful to book rooms so that the PAL sessions appear on students’ official timetables, however the constraints involved – finding times when both sets of students, staff and rooms are available - can be problematic. Getting volunteers from the final year student group has not been a problem. These students are very focussed on their studies and are keen to gain a good degree grade, and since involvement in the PAL scheme does not – for them - provide any academic credit there was a concern that they may be reluctant to take part. Despite this, enough volunteers were keen to take part, suggesting they felt that the employability skills gained made it worthwhile.

One other important factor in final year student engagement with the scheme is that many of the students on the course plan to go into teaching as a career. They see the PAL scheme as a way of gaining very relevant skills, and of strengthening their CV.

**Evidence and recommendations:**

Evaluation sessions are held midway through the Semester, and at the end of the scheme in January. All participants were asked to comment on what they felt were the good and bad points of the scheme, and what they felt they gained from it personally. The PAL leaders felt they had developed their interpersonal and leadership skills, and that the experience would significantly enhance their CV. Specific responses include:

- *“Being on the same wavelength as the PAL group aided rapport greatly. It is easier to be honest and speak up to a student PAL leader as opposed to a lecturer”* - PAL Leader
- *“It’s certainly made me more confident speaking up in front of a group of people I don’t know. It gave me a good idea of how people work together in a group too, something that you don’t notice as much if you’re actually working within the group”* - PAL Leader
- *“We got to ask questions and see how the uni life was. As the ‘Pals’ do Maths too they gave us advice on what to do and what is best. As we just started it helped us to form friends”* - First year student

Benefits for PAL leaders include:
- developing personal skills such as leadership, teamwork, interpersonal communication, facilitation and coaching skills
- gaining confidence especially in situations when teamwork is required to attain a goal
- valuable experience to enhance their CV
- experience in managing groups

Benefits for the first year students include:
- smoothing the transition into HE by providing contact with more experienced students who can offer academic and pastoral support.
- helping with social integration
- learning team-working skills

Benefits for academic staff include:
- helping to foster a learning community
- practical help managing the tutor groups, and input into the assessment process

**References / more information:**
Context: There is a considerable body of research literature supporting the claim that both student achievement and the development of graduate employability skills are enhanced by the inclusion within the curriculum of structured processes that develop the ability for self-reflection. Students should be able to identify their strengths and weaknesses, formulate strategies for addressing the weaknesses and plan for their own personal, educational and career development. This has a special impact in Mathematics, where students may have less well-developed skills of articulation.

Implementation (including barriers and enablers):

The Mathematics programme at Sheffield Hallam University has since 2001 incorporated a web-based Progress File system. The system requires each student to engage with the reflective progress on a continuous basis, providing regular reflective entries in their Progress File for each module, and receiving academic credit for doing so.

In year 1, students are expected to make entries for each module at least weekly. These entries are assessed, and provide 20% of the mark for one module. Each student receives simple weekly feedback in the form of a mark awarded against published assessment criteria. At the end of the year students provide a longer reflective summary of their development over this time, for which they receive fuller email feedback.

In year 2 the entries are marked every other week with the marks again contributing towards a core module. The logbook marks comprise part of a general employability element of assessment in this module, as students prepare to apply for an industrial work placement.

In the final year, the logbook assessment is built into the Project module, comprising 5% of the 30 credits available. This keeps the Project work higher on students’ list of priorities and helps tutors to track progress.

Although entries made by each student are hidden from other students, all are visible to staff, who can view all entries by a particular student, all entries for a particular module or simply the latest entries. Students quickly develop a culture of topping up their logbook entries at every opportunity, and so this last approach provides an extremely useful way for staff of getting feedback on lectures, for example, within hours of delivery. It also means that as a member of staff, you get a very clear idea of how your module material is being received across the whole group, and whenever a problem starts to occur it can be dealt with very quickly. The system provides an easy way to reply to a student entry by email, so this can be done very easily. It is much more effective than relying on staff-student meetings to gather feedback on the progress of the course – for one thing, it’s much more immediate, so problems can be dealt with before they become serious. For another, it’s much more representative – all students can provide comments, even those who might not otherwise have the confidence to contact staff.

The main barrier to effective student participation is their commonly held initial view that it is unrelated to their course, and a lack of clear understanding of its purpose. The first of
these difficulties can be addressed by engaging students in a shared discussion around what it might take to make them a more effective student, and raising their level of achievement.

The second difficulty can be tackled both by a clear explanation, repeated as necessary, of the purposes and benefits of the process of self-reflection, and by seeing (through trying it out) that it does in fact work. Once a student finds that they gain a real benefit from the system, their engagement should improve.

For staff the principal barrier is the time required to read and respond to comments (and to assess the entries). Although staff perception is that regularly reading and responding to the latest comments is quite time consuming, this can actually be done very easily because of the way the system is set up. Furthermore, this is offset by the benefits that follow from the rapid resolution of problems - improved retention, student satisfaction and engagement and the development of a shared community of learning.

Evidence and recommendations:

At the end of each year, first year students are asked to provide a summative review and feedback of the system: “.. the progress file has helped me to develop my communication skills and to become more confident in talking about my own work .. it allows you to see how you have progressed, or dealt with any personal problems.”

A further measure of success comes from the National Student Survey. The last three of the 21 specific questions address students’ personal development:

Q19: This course has helped me present myself with confidence,
Q20: My communication skills have improved,
Q21: As a result of the course, I feel confident in tackling unfamiliar problems

In 2008, the scores for Mathematical Sciences at SHU was 91%, 91% and 94% for these three questions, respectively. In 2009, the scores increased to 95%, 95% and 97% respectively. Nationally, Mathematical Sciences at SHU has been ranked 1st for this area in each of the last three years 2007-9.

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 also 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.

Students are active partners in learning, and the purpose of each activity should be explained and justified to them. Progress Files are no exception!

References / more information:
http://employability.shu.ac.uk/casestudies/JeffWaldock.pdf
Context:
One of the principal barriers to the introduction into the curriculum of processes that develop graduate skills is the perception that this will reduce the space for mathematical content. There are several responses to this. One is the possibly radical suggestion that we include more content that is necessary, given the type of employment that the majority of mathematics graduates progress to. Certainly, the number of graduates that follow a research career, for whom the content is necessary, is small; for the rest, there is considerable value in the inclusion of processes that explicitly develop their ability to work in teams and to communicate clearly, as well as the more mathematical skills such as logical thinking and problem solving. The first argument, therefore, is a philosophical one - concerned with the fundamental question of what a particular programme's aims are, and what it is we expect a graduate from it to be able to do.

A second argument - equally important - is that the curricular content is not necessarily curtailed by the inclusion of processes designed to develop graduate skills. There are ways of organising the delivery and assessment of the material which can develop these skills at the same time as delivering the existing core content.

Thirdly, a related argument concerns the student perspective of their degree course as a whole. Do we do as much as we can to help them see how each course based activity, each lecture, tutorial, seminar and element of assessment, is designed as part of an organic whole; how each complementary piece fits together, leading to the rounded graduate we hope to see at the end of the course? If each student is able to see how, like a jigsaw puzzle, each activity fits into the big picture, their levels of engagement (and hopefully achievement) will increase, as well as their satisfaction with the course.

Implementation (including barriers and enablers):
On the BSc Mathematics programme at Sheffield Hallam University, students are made explicitly aware of the course aims, and of the need for generic skill development before they apply, as it is discussed at open day presentations. It is important that students understand that since there is no HE equivalent to the National curriculum, there are a variety of mathematics degrees around, and they need the information necessary to make the right choice.

The programme is designed so that skills development is thoroughly embedded in all aspects of Learning Teaching and Assessment, at each level. Some examples are:

Throughout the course, students use an electronic logbook to reflect on progress, to identify problems and to develop action plans to resolve them. This is discussed in more detail in the Case Study on p16.

Students in year 1 work in small teams on a project for one particular module, and are expected to deliver an oral, written and poster presentation on the results.
As part of a different module, they are expected to write an essay, reflecting on their own skill development, identifying where in the course each of the key skills is being addressed and relating this to the Mathematics benchmark statement. They are supplied with links to a range of relevant and recent electronic publications, so that they gain a better awareness of current and pedagogical issues.

As far as possible all assignment briefs highlight what skills that work is helping develop.

To address the problem of developing skills at the same time as retaining sufficient course content, a wide variety of approaches to learning, teaching and assessment are employed.

Group work is used at all levels to encourage the development of team-working skills; part of the assessment involves self and peer assessment, to reward this aspect of skill development.

Communication skills are developed in a variety of ways: written communication through essays, reports, poster presentations, electronic presentations and a final year dissertation. All students create and maintain a personal website - their electronic portfolio of work - leading to the development of skills in electronic communication. The use of web 2.0 social networking tools is not currently embedded in the course; it is currently felt that these are best kept extra-curricular.

Oral communication is developed through presentations - in a 'low stakes' group setting in year 1, through to individual presentations delivered to a larger audience as part of the final year project.

In terms of barriers to success, it is important that a consistent approach is adopted by all staff teaching on a particular programme. There needs to be a shared understanding of the underlying philosophy in terms of course delivery and assessment, which is sometimes difficult to achieve in practice. There may also be institutional constraints that limit the ability of the course team to operate freely.

**Evidence and recommendations:**

The best evidence for success comes from student feedback:

"I feel the Hallam Maths course has had a massive impact on me and my career. I found that the way the course was delivered helped me engage with maths a lot more and built confidence in my ability."

"The Hallam maths course was a great foundation for my career because it not only provided the theory, but allowed us to apply that theory to real problems in a way that workplaces use."

"As an individual, I now feel more confident because I have gained many new skills."

"I feel that the way in which the course encouraged me to investigate problems has been of great benefit during my PhD. I seem to be more confident in my ability to work without supervision than some of my peers who did a more "traditional" math degree. The progress files in particular gave me the idea of keeping a daily log of what I have done and this has been invaluable when it comes to writing up my research."

**References / more information:**
Institution: Sheffield Hallam University  
Department: Engineering and Mathematics  
Name: Jeff Waldock  
Title / Scheme: Placement Preparation  
Skills Addressed: Career management, interview preparation, CV development

Context:
The BSc Mathematics programme at Sheffield Hallam University includes an optional industrial placement year, between the second and final years of academic study. Students are encouraged to complete a placement, firstly because of the marked improvement in employability that it brings, but also because the improved skills in self-management, organisation and work ethic that students get from a placement also help them gain better final year grades. Students who do not wish to do a placement – even after these facts are presented to them – go directly to the final year, and complete a full-time degree. Students wanting to do a placement register with the Faculty’s placement unit, and are interviewed on their preferences (job type, location etc). They are then notified as relevant opportunities arise, and must then prepare an application; if shortlisted they will also need to prepare themselves for the interview. During the first half of the first semester, the course curriculum includes a series of placement preparation classes which aim to provide students with skills to help in this process.

Implementation (including barriers and enablers):
The placement preparation sessions form part of one of the second year modules – equivalent to 6% of the academic credit for the year. There are six sessions provided, as follows:

- Week 0 (during induction week): Career intentions, opting in or out of placements, preferred jobs and locations.
- Week 1: Presentation from Careers service; careers options questionnaire; guidance on CV development; assess/discuss own CVs
- Week 2: Making a job application – Researching the company, writing covering letters. Personality tests – try one and read/analyse the feedback. Understanding what employers are looking for.
- Week 3: Handling difficult questions – see some, try some, discuss some. Be prepared!
- Week 4: Attend poster presentations given by students returning from placement. Interview students and mark at least 3 of them.
- Week 5: Choose one of a selection of sample job advertisements, and make an application for it.
- Week 6: In a whole-class setting, carry out an interview of 2 or 3 students (volunteers!) for the job applied for in week 5. Discuss afterwards with the whole group.

Each week, students hand in a summary of their work for assessment.

Evidence and recommendations:
One of the main problems when running sessions developing general skills such as these is the need to demonstrate their relevance, so that students engage productively with the exercises. Although there were a number of students who did not want to take an industrial
placement year who did not find the session very useful, the majority do have a keen interest in what lies ahead of them after finishing their degree, and can see that a placement year will provide them with invaluable experience to enhance their CV. Some of the comments received demonstrate that they saw value in these activities:

“We looked at job vacancies and then had to write a covering letter to go with that particular vacancy. I found this very useful as, had i had to do it alone, i would have struggled knowing what to write. I have now got the basic draft of a covering letter and know how to set it out and make it look professional.”

“So far i have found the employability lecture to be very helpful, i have never felt confident about writing a cover letter or how to answer difficult questions posed on Application forms or in interviews”

“I found that filling out the application form questions was difficult but was also very helpful, it got me thinking about myself, and what I’ve achieved and where my skills lie. I felt that it helped to talk to someone that knew me really well to see how they thought I could answer the questions too and it’s strange what you forget or don’t realise is actually a big achievement.”

“Working in pairs we had to assess people’s covering letter, C.V and application form, as well as state whether it was tailored to the job specification. I found this quite hard to do as we were criticising people’s work, however I think it was a really good exercise and has given us a more in-depth insight into what needs to be included when applying for a job.”

“Employability has been so helpful in making me realise what is needed to become a successful applicant in any job. I would have never fully understood the process of getting a full time job which would hopefully lead to a career if it wasn’t for employability.”

“This lecture nicely wrapped up this component of the module as we got to see an example of a live interview and the sort of questions that would be asked. You could feel the atmosphere which was great and you got the chance to comment on the positives and negatives of the interviewee.”

“Today was our final formal tutorial for employability and I really enjoyed it as [student 1] and [student 2] had to go through an interview. This gave me a really good idea of what not to do in an interview.”

“I found this session the most useful, as I have never had a formal interview, and so it has helped me in what I need to do on entering the room, as first impressions count for a great deal. From this session I have taken techniques that I am able to use in interviews of my own to improve my chances of being employed.”

References / more information:
Embedding Graduate Skills in Mathematics Programmes - Case Studies

Institution: Nottingham Trent University
Department: Science & Technology
Name: Peter Rowlett
Title / Scheme: Using Art Gallery Problems to develop mathematical and employability skills in a higher education group project
Skills Addressed: Identifying assumptions in mathematical arguments; referencing; communicating using reports and presentations; team working.

Context:
Transferable skills are an important part of undergraduate mathematics training [1] [2] [3], contributing to graduate employability [1] [2] and helping to satisfy employer need [4] [5]. However, it is not always apparent to students that skills development should form part of an undergraduate mathematics curriculum [6] [1].

Group work can be used for the development of skills [6] [7], but may be less well suited to the introduction of difficult new mathematics [3] [6] [8]. Skills training and guidance can be helpful, rather than just asking students to perform tasks and hoping skills development follows [1] [6]. There are issues in group work of determining whether equal contribution has taken place [6]. Peer assessment is recommended [8], perhaps in the form of formal minutes indicating actions and progress [5].

Problem Solving is a 20 credit, year long, second year module for BSc (Hons) Mathematics students. It has no pre-, post- or co-requisites. The module aims and outcomes relate to the development of transferable skills rather than the mastery of a specific mathematical syllabus and so the use of group work and projects is in accordance with the findings in the literature.

Implementation (including barriers and enablers):
Students were required to research a mathematical topic in groups to answer a set of problems, then to explore the topic more broadly in a direction of their choosing. Following the advice that the project not be mathematically difficult if the aim is skills development [3] [8], the topic of Art Gallery Problems was chosen as requiring no prerequisite knowledge and being mathematically simple from first principles. These are problems of determining the number of guards needed to keep every point in a room under surveillance. Original research in this area was motivated as "an interesting geometric problem" ([9], p. 1) and not, in the basic form used in this project, to be considered as an applied mathematics technique. There are many simplifying assumptions that make these techniques practically unworkable.

Students completed an 8 week group project, presented as if for a client. Students were asked to provide justified answers for how many guards are required for each of 12 specified museum layouts.

Presenting the students with a problem that encourages them to research and apply pure mathematics techniques as though they were applicable to the real world means there is plenty of room for critical thinking. In applying mathematics to real scenarios, it is always important to consider the assumptions made and the limitations of the model used. In many areas these can be quite subtle; for Art Gallery Problems they are quite apparent and this
Embedding Graduate Skills in Mathematics Programmes - Case Studies

provides an excellent teaching tool. Students answered the problem in a report to a non-mathematical audience, the client. Students also documented their techniques for a mathematical audience, as an in-house technical report. In this, students were asked to provide a critical analysis of the appropriateness and limitations of the model used to solve the client's problem and to outline some possible extensions to the theory to address these limitations. Finally, students gave a group presentation outlining their research into possible extensions.

No formal mathematical training was given on the topic but an indicative initial reading list was provided. Skills development activities were given on 'Teamwork' and 'Questioning the assumptions in a mathematical argument' as well as more structured classes on 'Finding and using references', 'Report writing' and 'Giving presentations'.

Marks were assigned for both reports, the presentation and for group management. This latter was an initial 400 word plan of work, one week after the problem was set, and minutes from weekly group meetings showing actions and progress for each member and group progress against the plan of work.

**Evidence and recommendations:**
A feedback questionnaire in the first class after completion of the project was completed by 28 students who were present out of the 36 total students.

- **Suitability of content:** Students agreed that the project did not require prerequisite mathematical knowledge. The majority rated the difficulty, compared with their other modules, as "easier" (13 students out of 28) or "about the same" (13/28).

- **Skills training:** Students were asked to rate the "usefulness in completing the project" of the structured skills development sessions they had attended. Most found the sessions helpful: 'Finding and using references' (20/28), 'Report writing' (20/27) and 'Giving presentations' (16/25).

- **Enjoyment of the work:** Students were asked to rate their enjoyment of various aspects of the project. A majority of students enjoyed " Undertaking self-directed learning" (18/27) and "Working as part of a team" (17/28). There was almost an equal number enjoying and not enjoying "Giving presentations", "Writing for a business audience" and "Writing for a technical audience". A substantial minority (9/28) did not enjoy "Art Gallery Problems as a topic".

- **Team working:** 24 students agreed with the statement "This project fostered team cooperation and oral communication" (taken from [7], p. 47); the remaining two who answered were unsure.

- **Group management and equal contribution:** 20 students felt the plan of work was helpful in organising the project and the remaining six who answered were neutral. 16 students felt the minutes were helpful, eight were neutral and two felt these were unhelpful. Particularly, 6 of 8 group Chairs and 5 of 6 Minute takers felt the minutes were helpful. However, only 12 students agreed with the statement "All team members contributed to the project equally", seven disagreed and seven answered "unsure".

- **Importance of skills development and its place in the curriculum:** All 28 students agreed with the statement "A mathematics graduate should have transferable skills". This was followed with the statement: "A mathematics student should be taught transferable skills as part of their degree (for credit)". 18 students agreed with this,
eight were neutral and two disagreed.

**Conclusions**

Skills development was regarded as important but students were less certain that this should form part of formal curricula. Art Gallery Problems provide a useful topic for skills development, not requiring prerequisite knowledge or being too difficult, but were not liked by all students. Plan of work and minutes of meetings were regarded as an effective method for team management but not as completely effective in ensuring everyone makes an equal contribution. The provision of skills training sessions was regarded as useful.

Some student comments are given below:

“Good [project]. Enjoyed it. I feel that my transferable and group work skills have improved.”

“Excellent eye-opener for average students into the world of business; deadlines and expectations.”

“This module has really helped me realise my potential, given the boost I needed for my future after university.”

“Even though the skills gained in this module are useful, I feel that more skills could be usefully taught to undergraduates that would be required in the business world.”

But, as a warning: “Don’t subject future 2nd years to this assignment.”

**References / more information:**


**Institution:** University of the West of England (UWE)  
**Department:** Engineering Design and Mathematics  
**Name:** Kevin Golden and Guy Roberts  
**Title / Scheme:** Graduate “skills” Development Programme (GDP)  
**Skills Addressed:** Reflection, teamwork, communication, presentation skills, employment awareness

**Context:**
In 2006, UWE launched a university-wide Graduate Development Programme to deliver a consistent approach to the development of “graduate skills and attributes” for undergraduate students. The development of the programme followed a University employability project which identified a number of skills and attributes sought after by employers of graduates, regardless of discipline. The same research revealed a high level of expectation from an overwhelming majority of undergraduates that the University had a responsibility to “make them more employable”. The top ten skills and attributes identified by the employability project were team working, motivation, initiative, problem solving, independent working, confidence, resilience, interpersonal skills, emotional intelligence and being open minded. While the academic programmes of study themselves cover a number of these skills, it was felt that others required additional resources and a specific focus to ensure that students were supported throughout their studies and prepared for the world beyond university.

**Implementation (including barriers and enablers):**
The planning of the content of each GDP programme was devolved to the programme level with the caveat that certain themes are covered at particular stages of a programme of study and that the deliver style is student centred. The overall aim of the programme is to encourage students to be reflective and self critical and to update their skills and personal profiles as they develop through their degree. Activities are defined at different levels as shown in figure 1 below.

<table>
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| • Transition to university (expectations)  
• Making use of feedback (tutorials, coursework, reflection, exam preparation)  
• Projects (research skills, leadership, managing groups, teamwork, presentations)  
• Employment awareness (CV preparation, placement opportunities)  
| • Transition to level 2 study (expectations, reflection)  
• Employability (updating CVs, applying for placements, employer engagement talks)  
• Final year projects (What is involved, developing a project, finding a supervisor, preparation)  
| • Transition to the final year (expectations, reflection)  
• Finding employment (updating CVs, employer engagement talks)  
• Continuing professional development  
• Managing final year projects  

*Figure 1: Outline of GDP programme*

The level 1 programme is delivered to mathematics students in group sizes of sixteen over twelve sessions. For the other levels the group sizes can vary depending on the activity and the number of sessions reduced to eight sessions for level 2 and four sessions for level 3. The style of each session is that it should be student led with the academic acting as a facilitator. On completion of each level, students receive a GDP certificate provided they submit a short essay reflecting on the progress they
have made during the year.

The main barriers for the success of this type of scheme are generally concerned with staff and student engagement. Resources are allocated to GDP tutors to prepare and deliver sessions, but in addition to this a series of training events were held prior to the start of the programme to introduce what to many academic staff was an unfamiliar style of “teaching”. GDP coordinators were identified for each programme and encouraged to share materials and approaches. A University-wide review of the GDP scheme is an ongoing part of the University calendar. The scheme is promoted to students as an integral part of their studies. During open days and induction, the GDP programme is given high visibility with various promotional materials.

To date, for mathematics students, the GDP programme has been delivered as a stand-alone programme, providing an additional resource to promote awareness of important issues that can appear to fall outside the remit of the mathematics modules. This is particularly true of issues concerning the employability of mathematics graduates and is valuable given that many new mathematics students are unaware of the employment opportunities open to them. However, in the next academic year a number of the GDP sessions will be integrated into the academic programme delivery. This is partly to ensure that more students engage in this ongoing skills development but also that a number of modules are changing the way material is delivered to provide enhanced opportunities for feedback through regular group discussions and presentation of work.

**Evidence and recommendations:**

It is probably far too early to comment on the success of the GDP programme since only two cohorts have completed their degrees while the programme has been in place. During the past four years we have increased our student numbers and increased the tariff on entry to the mathematics degree while maintaining good progression statistics. So we cannot claim that this performance is to do with the implementation of a skills programme as opposed to recruiting stronger students.

In each of the years of running the GDP programme between one third and one half of the first year students have submitted a reflective essay at the end of the year. While this participation is low, it should be noted that submission is voluntary. Among those who submit this essay, there are some very interesting comments which show that they have clearly developed their perception of what their degree is about and focus over the year. The essays provide valuable feedback about their view of particular modules. The views expressed are generally constructive and honest about their own strengths and weaknesses and about the experience of studying our programme. In the vast majority of cases the students are very positive about their experience at the University. In one sense they provide more valuable information than that obtained from end of module questionnaires. Completion of the programme at levels two and three is much lower although attendance at sessions involving final year options, projects and placements is generally high.

The changes we are making to the programme this year are partly motivated by a desire to increase participation at level one. This is where we need students to settle and make the transition from school to higher education. While evidence for success is mixed, it seems that there is a clear benefit at level one to those who engage, although it is also probably true that our most engaged students are those who participate in the GDP programme. That said there is real value in the feedback these students have provided to us.

The University always envisaged that the GDP programme was more than a skills development programme, but that it would influence the way we taught our modules. Four years into the programme we can see this process starting in the mathematics degree.

**References / more information:**

Description of UWE GDP programme [http://www.uwe.ac.uk/gdp/index.shtml](http://www.uwe.ac.uk/gdp/index.shtml)
A classification of *Graduate Skills*:

**PLACEMENTS and WBL**

**Placement preparation (L4/L5)**
- CVs
- Job applications
- Researching the company
- Interview techniques
- Answering difficult questions
- Interview types, and activities

**Placement Reflection (L6)**
- Presentation / Poster
- Report

- Career management
- Enterprise skills
- Entrepreneurship
- Innovation
- Commercial/sector awareness

**SKILLS DEVELOPMENT**

(A degree is *more* than ***)

- Communication
- Team-working
- Leadership
- Problem solving
- Reflection and action planning
- Logical argument
- IT skills
- Numeracy
- Transferability
- Self-motivation
- Self-management
- Self-efficacy
- Adaptability
- Reliability
- Leadership skills
- Articulation

...oomph!
## Mechanisms and inputs for embedding *Graduate Skills:*

### INPUTS
- Employers
- Academic Tutors
- Careers Service
- Research
- Employability Statements
- Self Evaluations (AQR etc)
- Course reviews
- NSS
- Internal Academic Review
- Student Feedback
- Student Union
- QSME processes
- LTA ‘good practice’
- Student support services
- Widening Participation
- Diversity

### MECHANISMS

#### Assessment Practice:
- Written presentation
- Oral (group/individual) presentation
- Highlighting the purpose & benefit

#### LTA practices and styles:
- Problem-based learning
- Enquiry-based learning
- Project work
- Simulated tasks
- Seminar work
- Group work

#### Personal Development Planning:
- Reflective practice, organisation
- Problem identification
- Action planning & target setting
- Encourage self-awareness
- Reporting and evaluation

#### e-Portfolios

#### Peer-Assisted Learning

#### Mentoring

#### Extra-Curricular Work
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<td>Career planning and management</td>
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<td>Commercial awareness</td>
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<td>Initiative, enterprise</td>
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<td>LaTex and Office skills</td>
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<td>Leadership</td>
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<td>Logical analysis and problem-solving</td>
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<td>Personal/action planning</td>
<td>4, 6, 16</td>
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<td>Presentation skills</td>
<td>8, 14, 22, 25</td>
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<td>Self awareness, reflection</td>
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<td>Subject-specific skills</td>
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<td>Team-working, networking and Interpersonal skills</td>
<td>4, 8, 10, 12, 14, 22, 25</td>
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<td>Time management and organisation</td>
<td>4, 16, 18</td>
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<tr>
<td>Verbal communication</td>
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<tr>
<td>Written communication</td>
<td>6, 10, 16, 22, 25</td>
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References


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