This project had three principal aims:

1. To capture examples of what is currently being done within Mathematics programmes in UK HEIs to address the development of graduate skills,
2. To provide an appraisal of what approaches appear to have been successful in developing these skills, and
3. To use this to make recommendations for the further development of these and other programmes of study that wish to encourage the development of graduate skills.

Although a number of graduate skills can be developed through extra-curricular activities, this project investigated curriculum-based approaches.

A set of 17 case studies from Mathematics departments at a range of UK HEIs were collected illustrating successful approaches to the development of graduate skills in different contexts and at different levels. These have been published in a booklet, and a workshop tour of five of the National HE STEM Programme Spoke regions has been carried out to publicise and disseminate the results. A subsequent call for small ‘Developing Graduate Skills uptake programme’ bids has led to three new projects, stimulated as a result of the case studies presented in this booklet.

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, particularly with the large rises in tuition fees imminent, 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 new measures by which they can judge the performance both of Universities and of individual programmes, such as the National Student Survey, the Destination for Leavers from Higher Education survey of graduate employment and the various league tables, as published for example by the Guardian and the Times.

By August 2012, HEFCE expects all universities to publish Key Information Sets (KIS) for each of their courses on their institutional website, ‘providing prospective students with information about the HE experience that we know they find useful, in places we know they look for it’ [1].
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The KIS data will include student satisfaction metrics, learning and teaching activities and assessment methods, study hours, course accreditation, accommodation costs and graduate employment and salary outcomes.

In what is certain to be a very competitive student recruitment ‘marketplace’ there will be considerable importance attached by each university and by each course to presenting a successful profile against each of these measures. This is especially true at a time of high levels of graduate unemployment. The Guardian, for example, recently reported that “20% of recent graduates are unemployed – the highest proportion for a decade”[2] and “Almost half of all recent graduates believe their university education did not adequately equip them for the world of work”[3].

One immediate outcome has been the requirement from HEFCE that by August 31st 2010, all universities should publish an employability statement. This is described as “a short summary of what universities and colleges offer to their students to support their employability and their transition into employment and beyond” and is intended “to help prospective students make informed choices for entry in 2011-12”[4].

In addition, the HE Mathematics community has implicitly identified the importance of the skills element of the curriculum through the National Benchmark Statement [5]. Reflecting the diversity of provision to be found across the UK in the discipline, it says very little about subject content, only explicitly referring to calculus and linear algebra. General skill development, however, is prominent:

“MSOR graduates will possess general study skills, particularly including the ability to learn independently, using a variety of media that might include books, learned journals, the internet and so on.

They will also be able to work independently with patience and persistence, pursuing the solution of a problem to its conclusion. They will have had the opportunity to develop general skills of time management and organisation. They will be adaptable, in particular displaying readiness to address new problems from new areas. They will be able to transfer knowledge from one context to another, to assess problems logically and to approach them analytically.

They will have highly developed skills of numeracy, including being thoroughly comfortable with numerate concepts and arguments in all stages of work. They will typically have general IT skills, such as word processing, the ability to use the internet and the ability to obtain information, always exercising these skills in a responsible way and taking care that sources are referred to appropriately.

They will also have general communication skills, typically including the ability to work in teams, to contribute to discussions, to write coherently and to communicate results clearly.

Where appropriate, they will have knowledge of ethical issues, including the need for sensitivity in handling data of a personal nature. All of these competencies enhance the general employability of MSOR graduates; see paragraphs 1.24 to 1.27.”

This of course raises the question – to what extent does the current curriculum in MSOR disciplines (and the learning, teaching and assessment strategies that deliver, support and assess it) incorporate these principles - and where it does, how successful is it? There is no objective measure of this, but a subjective measure comes from the National Student Survey, one section of which addresses the area of personal skills.

Table 1 gives the ranking of the Mathematical Sciences, as a discipline, against other subjects1 on three relevant NSS questions over four years (2008-2011). An interactive view of the rankings for all 22 questions for Mathematics, for 2008-2011, is available at: https://maths.shu.ac.uk/NSS/skills2.php.

These data clearly suggest that students studying Mathematics perceive a problem in terms of their development of personal skills – at least, in relation to their own expectations. The consistency in this pattern over the last four years suggests further that there is a need to tackle the issue. Should we as a community be supporting each other in developing new approaches to skill development within Mathematics programmes and, if so, how?

1Those listed at Level 2 in the raw data returns from the survey. These data are available at http://www.unistats.com/

<table>
<thead>
<tr>
<th>National Student Survey Question</th>
<th>2008 (52)</th>
<th>2009 (62)</th>
<th>2010 (63)</th>
<th>2011 (63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q19: The course has helped me present myself with confidence</td>
<td>66% 42nd</td>
<td>66% 42nd</td>
<td>70% 42nd</td>
<td>71% 42nd</td>
</tr>
<tr>
<td>Q20: My communication skills have improved.</td>
<td>66% 42nd</td>
<td>65% 42nd</td>
<td>70% 42nd</td>
<td>70% 42nd</td>
</tr>
<tr>
<td>Q21: As a result of the course, I feel confident in tackling unfamiliar problems.</td>
<td>75% 30th</td>
<td>77% 28th</td>
<td>77% 28th</td>
<td>79% 23rd</td>
</tr>
</tbody>
</table>

Table 1: Data for ‘Mathematical Sciences’ from the National Student Survey, Questions 19-21, averaged across all institutions reporting, and its rank within the 42 Level 2 subjects. The number in brackets after the year indicates the number of universities included in the average.
**Implementation**

There are significant barriers involved 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 - through different approaches toward learning, teaching and assessment that allow skill development to take place alongside the development of the mathematical skills, and by encouraging students to take part in extracurricular 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 introduction of the Higher Education Achievement Record, as recommended by the Burgess Report [6], will provide further incentive for this.

This project, building on an earlier informal liaison between staff from a number of HEIs with an interest in this area, began with a preliminary meeting of representatives of six departments to share ideas and to form a plan of action. It was decided to aim for short (two page) case studies, focussed closely on the development of individual graduate skills. A subsequent workshop was held at Sheffield Hallam University, in November 2010, at which provisional case studies were proposed and others identified. Staff at other HEIs who had published relevant work were contacted and asked to provide a case study to an agreed template.

**Booklet, further development and sustainability**

The final booklet contained 17 case studies and a commentary which provided background and context, and drew out some common themes arising from the case studies. The published booklet presents a series of short case studies, each focussed on specific graduate skills, providing examples of ways in which these have been successfully developed through curricular initiatives. There is a wide variety of work reported, both in terms of the skills developed as well as the type of courses and institutions involved. The expectation is therefore, that there will be something of interest and relevance to everyone who has a desire to make curricular changes aimed at improving the ‘graduate’ skill levels of their students.

Following publication of the booklet in April 2011, a workshop was held at five of the six HE STEM regions. The workshops were attended by some of the case study authors, who gave short presentations on their work, and other staff who had an interest in developing graduate skills. Presentations of this work were made at the CETL-MSOR Conferences in 2010 and 2011.

As well as a print run of 500, the booklet has been made available via the website at [http://maths.shu.ac.uk/msor/graduateskills/](http://maths.shu.ac.uk/msor/graduateskills/). Up to 26/08/2011, 191 downloads of the document have been made from separate locations, representing 43 institutions in the UK, Australia and New Zealand.

A ‘Developing Graduate Skills uptake programme’ from the Mathematical Sciences HE Curriculum Innovation Fund offered a call for small bids specifically addressed at encouraging graduate skill development projects inspired by this set of case studies. In response to this call, three projects have been funded for 2011-12.

**Discussion of findings**

The requirement by HEFCE to publish employability statements has forced universities to articulate clearly exactly what it is they are providing students with in this regard, and to highlight the ways in which individual courses help students both to develop employability skills, and to recognise their importance. These have recently been reviewed by the Higher Education Academy [7]. One approach categorises 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, and may be used to identify a thread of employability activities throughout a course. An example is the Graduate Development Programme at the University of the West of England (Case Study 11).

It is very noticeable that nearly all – 14 of 17 - address generic employability skills, particularly communication and team working, reflecting the importance attached to these skills, and if allowance is made for the fact that career planning and PDP include elements such as self-awareness, the coverage is 100%.

The development of Career Management Skills (CMS) is the second most commonly addressed skill group, reflecting perhaps the increased desire both to raise students’ awareness of the potential career paths they may follow, and the practical skills necessary to succeed in them. It is noticeable that nearly all of the case studies that deliver CMS do so throughout the programme, recognising that it takes time to build these skills to an appropriate level.
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Project in brief:

Career Mentoring Scheme for Maths Students

Employees and alumni acting as career mentors for current undergraduates. Project leader: Jeff Waldock, Sheffield Hallam. Supported by the North East Spoke.