Title of case study
Embedding employability in the mathematics curriculum.

Staff Leads
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Name of course and module (if applicable) case study took place within.
Module - MATH390 Professional Projects and Employability in Mathematics.

Please briefly describe the activity undertaken for the case study
The new third year Mathematics module was designed with an aim of explicitly embedding employability. The module provides students with a range of opportunities to enhance their skills for graduate employment and the learning outcomes reflect this focus. Students work in groups for most of the module activities. The assessment comes from three rich mathematical group projects, reflective writing pieces after each group project, and an individual employability skills portfolio. The projects were designed in collaboration with industrial partners, providing students with experiences of working on genuine problems which mathematicians face in graduate employment. This explicit embedding approach aims to engage students by developing skills through work on discipline-specific projects.

Fruitful discussions with Careers and Employability led to the creation of sessions and activities focused on particular skill areas, and these were scheduled to tie in with specific tasks in the module. The group projects themselves adopt a phased inquiry-based approach where students are provided with less structural scaffolding for each new project. The aim of this approach is that creativity and perseverance will develop through the course of the module.

An application process was launched at the usual module registration time. Students were asked to write a short piece explaining their reasons for wishing to study the module and their motivation. This process aims to ensure that students have thought carefully about the content and aims of the module. This is particularly important as the module has a different style and focus to more traditional Mathematics modules.

How was the activity implemented?

The module takes an active learning approach, with students engaging in activities on skills development and group work in PC lab sessions. One two hour session and a separate one hour session were held per week. The one hour sessions were used for briefings and activities on specific skill areas, such as presentation skills, commercial awareness, video interview techniques, and report writing for a client. These sessions were often delivered and designed by Careers and Employability. Activities in the one hour sessions provided opportunities for students to explore their own professional competencies. The two hour lab sessions were primarily used for in-depth group project work. Students were set three group projects in the module, with each having a slightly different focus. The first was a time-constrained challenge where students only had one week to complete a mathematical investigation and write up a report for a client. The two projects following this were focused on working for a client, and a formal mathematical research project for a client with a mathematical background, respectively.

The module learning outcomes emphasise the importance of not only conducting thorough mathematical investigations, but also communicating the results to client audiences (in both written reports and group presentations). Reflection is a key element of the module and students are required to write short reflective pieces frequently as part of the module assessment. These pieces ask students to consider their approaches to the tasks and identify skills which may have developed through engagement with module activities.

Has this activity improved programme provision and student experience, if so how?

Reflecting on their experiences in the module, students were able to identify important benefits of studying this module when compared to their more traditional Mathematics modules:

> "Previously I had no experience in creating reports and presentations for external clients. MATH390 has taught me valuable skills needed to be successful in a job when I graduate. Without this module I wouldn't have known these skills and therefore entered the world of work at a disadvantage. It has helped me to build on skills such as teamwork, time management, presenting, report writing. I think the University would benefit greatly from many more modules such as this." (Student comment).

The interactions with employers and the realism of the project work were valued by students:

> "We get to see the sort of things we will be doing when we get a job and get to know how our maths will be applied in real life. It was also useful to know the kinds of things employers are looking for when recruiting graduates." (Student comment).

A recurrent theme in the module reflections was the positive benefit of the module activities on student confidence and preparedness for graduate employment.

One of the projects in the module was designed in collaboration with The Very Group. The students who were deemed to have delivered the best client presentation were invited on a site visit to The Very Group headquarters in Speke. On the visit, the group met with many different people in a variety of roles (many of which they never knew existed) and were able to think about the different areas they could go into with a maths degree:

> "We never knew so many different roles existed for maths graduates. One that stood out the most to us was the credit risk team who would look into fraudulent customers which sounded so interesting. We also got to speak with current graduates and ask them about their experience with working at Very and what their jobs as graduate analysts entailed." (Student comment).

The students met with key members of staff, including recent graduates. The students also worked on a task similar to those which a data analyst at the company might work on.

The site visit had a very positive impact on the students:

> "This was a great experience and it meant that we could see what life was like after graduation and learn more about the prospects available to us as maths students. It was also a great networking opportunity and we all got many new connections on LinkedIn" (Student comment).

Did you experience any challenges in implementation, if so how did you overcome these?

Mathematics students can feel very uneasy with grade-based marking criteria which is used in the module as they are accustomed to a quantitative scheme used across most other modules in Mathematics. Providing students with activities on applying the criteria to sample reports and holding discussion sessions on this topic enabled students to feel more at ease with the application of the module marking scheme.

A robust audit trail for group management can assist the module leader in implementing peer moderation. In this module, groups were required to keep a log of agendas, minutes and actions from all group meetings. These documents had to be approved by all group members before uploading. This group management aspect provided students and staff with additional evidence for how the group operated and assigned work to individual group members.

Which Liverpool University Hallmarks and Attributes does this case study relate to (please indicate all that apply)

Research-connected Teaching	**X**
Active Learning	**X**
Authentic Assessment	**X**
Confidence	**X**
Digital Fluency	**X**
Global Citizenship	**X**

How does this case study relate to the Hallmarks and Attributes you have selected?

Research-connected Teaching

Students develop their research skills through work on the group projects. By investigating possible approaches to the problems and learning necessary novel techniques, students are able to enhance their problem solving and research abilities. Projects are original problems from industry and provide students with valuable experiences of mathematical research.

Active Learning

Students work in groups in a PC lab setting and spend the timetabled hours working on projects. Students are leading the way in their approach to the projects and are not passive attendees at the sessions.

Authentic Assessment

Industrial partners collaborate to design the projects, which originate from important original questions in their particular organisation. The project outputs (written reports and group presentations) are assessed using a grade-based marking scheme. Industrial partners provide input on the reports and presentations, and take a lead for the Q&A portions of the presentation sessions. This provides an additional check that students are addressing the client concerns given in the brief and appreciate the potential impact of their mathematical analysis on the various areas of the organisation and sector.

Confidence

The projects are open-ended and students can take a variety of different approaches. The phased inquiry-based approach to the structure of the projects means that students are gradually given more freedom in setting the direction of the projects as the module progresses, with less structural scaffolding provided for each new project. The aim of this structure is to gradually build student confidence in branching out and trying a range of different approaches. This is a necessary skill to develop when tackling genuine mathematical problems from industry. This phased approach builds student perseverance and confidence with the style of working expected in industry.

Digital Fluency

Through the group projects, students develop their digital skills, including presentation and research skills. Students collaborate with each other and industrial partners via a range of online platforms and channels. Students are given the opportunity to enhance their digital presentation skills through the requirement to produce presentations for a range of different client audiences. Students also have many opportunities to enhance their skills with mathematical software by utilising this with real data or in real scenarios.

Global Citizenship

Through interactions with employers and working on the projects, students develop an appreciation for corporate social responsibility and the manner in which businesses play an important role in a wide range of global and local issues. Employers make it clear to students that their project work must acknowledge this and any recommendations based on mathematical work should consider wider issues.

How could this case study be transferred to other disciplines?

The use of a grade-based marking scheme is perhaps not such an issue for some other disciplines. The lab session structure is easily adaptable to other subjects but the focus on particular elements should be adjusted. For example, Mathematics students do not have a great deal of experience in writing reports or reflective essays, so a substantial portion of the early briefings and activities were dedicated to these areas. This might not be necessary in other disciplines and the focus could be shifted to other areas. From this perspective, it's important to have good links with industrial partners to understand where the skills gaps are for graduates from your own discipline and concentrate on activities which will allow students to engage in the development of these.

If someone else were to implement the activity within your case study what advice would you give them?

- Allocate a good portion of time to the development of the projects themselves. A good partnership with industrial contacts is needed to bring together the nature of the discipline in higher education and also the reality of working with the discipline in industry. The projects should bridge the gaps here and allow students freedom to experiment and be creative, while appreciating the need to produce an output for a specific client.

- Take care to explicitly embed the employability so that students are seeing the discipline-specific relevance of the skills development.

- The success of this type of module requires careful module design and a collaborative effort between academics, Careers and Employability, and industrial partners. Discussions with Careers and Employability and industrial partners can help academics to create suitable learning outcomes, which are often skills-based.

- Don't be too concerned about going against the grain of what a "traditional" module in your discipline should look like. Embedding employability often requires academics to think about alternative methods for engaging students.

- Building student confidence requires the module leader to act in a motivational role. Unlike more traditional Mathematics modules, the module leader does not hold the "correct" answers or approach as there are many possible routes which students can take. The module leader instead must act as a motivational figure, encouraging students to persevere with the unstructured problems. Maintaining a good dialogue with students throughout the projects is essential.

Additional resources

- Russell, E.J. and Rowlett, P. "Professional skills development for mathematics undergraduates", Higher Education, Skills and Work-Based Learning, 9(3), pp. 374-386, DOI: 10.1108/heswbl-01-2018-0010.

- Russell, E.J. "Making the grade: supporting mathematics students in understanding the use of grade-based marking criteria for assessments", MSOR Connections, Vol 17, No. 2, pp. 68-74, DOI: 10.21100/msor.v17i2.962.