

CASE STUDY

Building mathematics students' careers knowledge and confidence through an extra-curricular industrial challenge

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Abstract

The Department of Mathematical Sciences at the University of Liverpool has a well-established strand of embedded employability activity in the mathematics curriculum spanning every year of undergraduate study. To supplement this curricular offer, an extra-curricular activity was offered to students in 2024. This article will provide details on the development of the extra-curricular activity set by a major employer based in the Liverpool region. The activity challenged students to work together in groups to consider the wider societal and cultural issues in working with mathematics for a major international business. A study was conducted with the participating students which aimed to investigate whether the activity had enhanced their knowledge and confidence about opportunities for mathematics graduates. The survey results demonstrate that participants were more knowledgeable about opportunities for mathematics graduates and developed confidence in their skills development through participation in the activity.

Keywords: active learning, group work, employability, skills development.

1 Introduction

A strand of embedded employability has been developed over several years in the mathematics programmes at the University of Liverpool. The aim of this strand is to provide students with opportunities to develop key employability skills as a core part of their degree. Embedded activity has been shown to be an essential element in promoting student engagement with such development (Bridgstock, 2009).

As part of this development, group tasks for simulated clients and open-ended project briefs have been incorporated into module assessment. A key feature of this strand is the final year capstone module Professional Projects. This module tasks students with working in groups to investigate authentic projects set by industrial partners. The structure of the embedded strand is such that students build their confidence and awareness of skills through the years of study and then have the opportunity to work on live projects set by real employers. During the development process, care was taken to ensure that the novel assessment approaches and tasks were in line with the module content, and that the new elements were appropriate forms of authentic assessment in the context. Throughout the strand, there is an emphasis on the benefits of reflection - students are required to reflect regularly in written pieces and in digital stories. The aim of this element is to encourage awareness of skills development and the articulation of skills acquisition.

2. Extra-curricular activities for employability

Extra-curricular activities take place outside of formal, timetabled curricular activity. Students are encouraged to participate in such activities as there are a number of possible benefits – employers want to see evidence of skills development and examples of the utilisation of these skills, and extra-curricular opportunities can provide this (Jackson et al., 2024, Waldock, 2011). There is evidence that extra-curricular activities have some positive impact on the enhancement of employability skills

(Ramesh et al., 2014, Moxey and Simpkin, 2021). Many authors with experience advise caution in making extra-curricular activities the central focus of employability development (Cranmer, 2006). The curricular offer should be prioritised as this is where students will focus their attention - development of these skills should be a formal part of undergraduate degree programmes. Extra-curricular activities can help to supplement embedded activities with opportunities for students to explore societal, commercial, or interdisciplinary perspectives on topics.

One of the main challenges with extra-curricular activities is understanding and compensating for barriers to engagement. As the activities are not formally a component of students' degree courses, the intended benefits must be clearly stated for students. Some authors identify financial pressure, lack of confidence, and study or work commitments as potential barriers to engagement with extra-curricular activities. It has been noted that students prioritise extra-curricular activities which offer a financial incentive, and those where networking and skills development are clearly available (Jackson et al., 2024).

3. Development of the challenge

An extra-curricular mathematics challenge was proposed as a Faculty of Science and Engineering Educational Enhancement Project. The faculty offered financial support to run the activity in the 2023/24 academic year. To add authenticity to the activity, an employer partner was sought to collaborate in setting an appropriate mathematical challenge for students. It was decided that the challenge should run over several weeks to provide time for students to conduct some analysis and collate findings. To promote the development of communication skills and teamwork, the challenge was proposed as a group task. Following discussion with the employer partner, it was decided that the output would take the form of a short group presentation as this is what would be expected in the business. The intended format of the challenge is given in the Table 1 below.

Table 1 – Format of the challenge.

Session	Activities
Week 1	• Ice breakers with student groups • Introduction to the context and challenge question from employer partner
Week 2	• Information session on mathematical careers at the organisation • Time for project work
Week 3	• Support with presentation planning • Finalising project findings
Week 4	• Presentation and celebration session • Networking with the range of employers in attendance

The employer who collaborated on the challenge is a large international business based locally. The proposed challenge asked students to consider proposals for product launches in two different territories. Students were supplied with data on the costs of ingredients for products, and data from customer focus groups in the two territories. Thus, the challenge asked students to consider a range of commercial factors in their proposals. It was hoped that this approach would demonstrate to students that the analysis is only part of a successful proposal, and they would need to spend time researching and appreciating the compromises needed in reaching a viable solution in the given context.

Due to the extra-curricular nature of the challenge, the timing of the activity was crucial. It was decided that the challenge would take place at the beginning of a semester (before students become focused on continuous assessment for their taught modules), and that the in-person sessions for the challenge would take place on Wednesday afternoons when there is no timetabled teaching activity. It was hoped that this approach would provide the best chance for students to engage with the opportunity. A PC lab on campus was booked for the sessions as the range of software available on campus PCs was useful for the analysis.

To make the challenge appealing to students, a prize (in the form of a gift voucher) was offered to the group deemed to have delivered the best final presentation. This was promoted as a key part of the challenge during recruitment. Lunch was also provided to students before each session. The opportunity was advertised to students in November 2023. Thirty-five students signed up for the challenge - eighteen Year 1 students, eight Year 2 students, eight Year 3 students, and one Year 4 student. The breakdown of the student enrolment can be seen in Table 2. For most programmes, just under 10% of the eligible cohort enrolled on the challenge. This was a good outcome for an optional, extra-curricular activity in the first year it was offered.

Table 2 – Student enrolment on the challenge by degree programme.

Degree Programme	Number of students
Mathematics	12
Mathematics and Economics	5
Actuarial Mathematics	5
Mathematics with Finance	3
Mathematics with Languages	2
Mathematics and Statistics	2
Mathematical Physics	1
Theoretical Physics	1
Mathematics and Philosophy	2
Mathematics and Computer Science	1
MMath	1

As 18 of the students were in Year 1 and had thus only completed one semester of university study at the time of the challenge, care was taken in forming the groups for the task. Five of the students in Year 3 had studied the capstone Professional Projects module in semester one and had thus tackled several projects set by employers already. These students agreed to be group leaders and time was taken to ensure that groups were balanced in terms of experience and skills.

As the task was open-ended, this provided scope for all students to propose ideas on the approach. Similarly, conducting an analysis of the data provided was only part of the challenge, and research into the different territories for the products was necessary. This aspect of the task provided space for all group members to contribute. Those who had much more experience in data analysis could focus or lead on the analytical work, while others could research the context for the problem and identify where the analysis alone might be insufficient to determine a useful solution.

4. Evaluation

As a formal evaluation of the activity, two surveys were administered over the course of the challenge. The aim of the study was to determine whether experience of the activity enhanced participant knowledge about careers for maths graduates, and whether the activity had any impact on participant confidence in several skill areas.

All students who signed up for the challenge were invited to participate in the study. Participant Information Sheets were distributed in advance of the challenge and students could choose whether to opt into the study or not. The first study was administered at the beginning of the first session to determine a baseline for participant careers knowledge and skills confidence. The second survey was administered in the final session of the challenge. The initial set of questions in the surveys were identical to allow for comparative analysis, while there were some additional questions in the second survey to allow participants to expand on their experiences of the activity. Twenty-four students participated in the study (a response rate of 69%).

Students were asked to respond to a series of statements on a 5-point Likert scale. Under this scale, “1” corresponds to “strongly disagree” and “5” corresponds to “strongly agree”. The statement on skills development was interesting as the comparison from Week 1 to Week 4 in Figure 1 demonstrates. Considering responses to the statement “I feel that I am developing the skills needed for graduate employment”, the mean in Week 1 was 3.04 and this increased to 3.39 in Week 4. The box plot clearly documents the positive shift in perception of skills acquisition over the challenge. 35% of student participants felt they were developing important skills for graduate employment in Week 1 and this increased to 55% in Week 4.

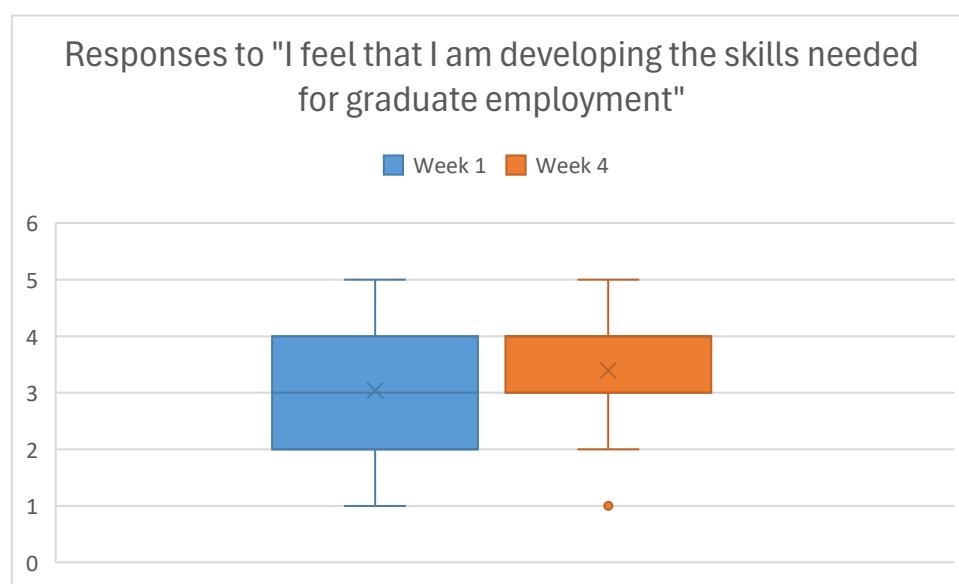


Figure 1 – student perceptions of their skills development.

One of the aims of the activity was to inform students about the range of mathematical careers available. The session delivered by employer representatives in Week 2 presented details on such opportunities explicitly. As can be seen in Figure 2, there were some improvements in awareness of career opportunities over the course of the challenge. The mean response to this statement was 3.29 in Week 1 and this improved to 3.67 in Week 4. 54% of participants felt aware of career opportunities open to them in Week 1, and this increased to 71% in Week 4.

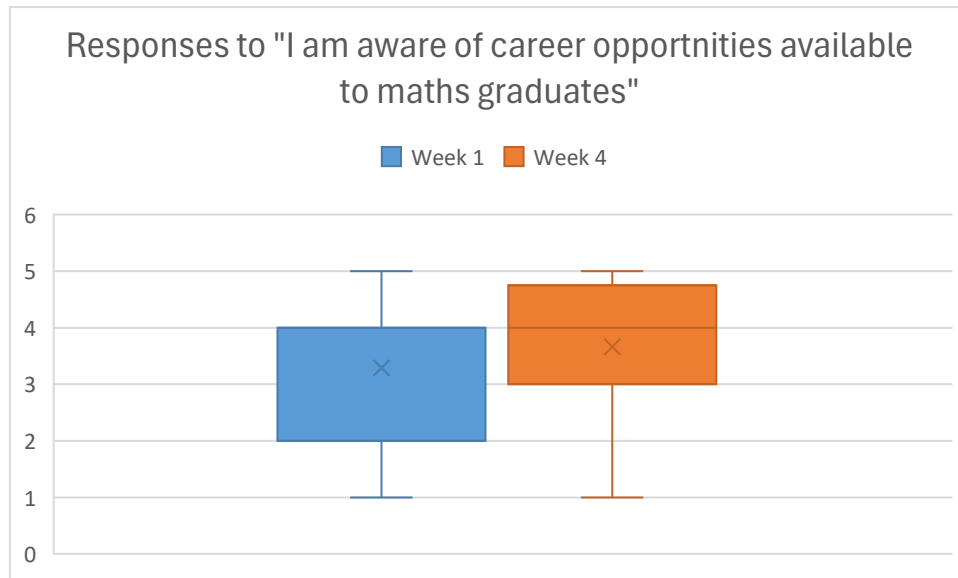


Figure 2 – student awareness of career opportunities.

Participants felt that the challenge provided them with some useful insights into how mathematics is applied in industry. As can be seen in Figure 3, 88% of participants felt that the challenge provided such insights.

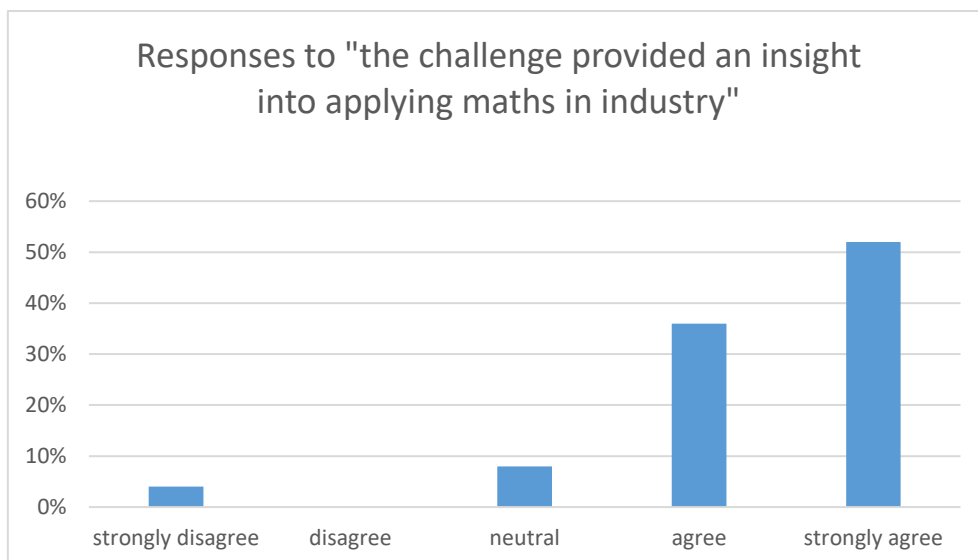


Figure 3 – student views on insights into applying maths in industry.

Over 90% of participants felt a positive impact on their communication skills. As the key output of the challenge is a group presentation, this finding indicates that participants felt positive about the

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group work and presentation elements. This is especially encouraging as for many students this was the first time they delivered a presentation.

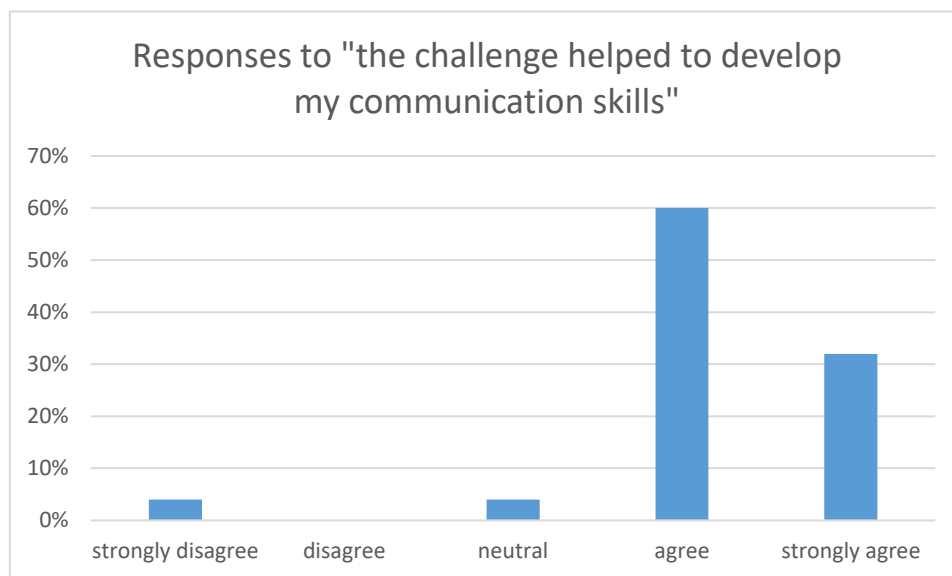


Figure 4 – perceived development of communication skills.

Free-text Comments

In the Week 4 survey, participants were presented with two optional free-text response questions. These asked what (if anything) was most beneficial about the challenge and what improvements could be made to the challenge in the future.

Those who responded to the first question (on benefits of the activity) highlighted the opportunity to enhance their communication skills. Specific responses to this question include:

"The chance to apply my maths skills and chance to learn from others."

"The presentation experience"

"Being able to describe results from maths in a way that was understandable by people in other aspects of a business."

When asked to identify any improvements which could be made, some participants indicated a desire for more guidance on how to tackle the problem:

"A bit more guidance as it's very vague especially for students with no experience."

"slightly more information in the brief as to how certain data was collected."

It is not unexpected that some participants noted the lack of explicit guidance in this task when compared to structured problems in traditional mathematics modules. Another aim of the task is to expose students to messy, authentic problems from industry.

5. Discussion

The findings from the study indicate that there are benefits to offering mathematics students extra-curricular activities. The format of the challenge provided scope for students to learn about many different areas where mathematics is used and also areas of business where their analytical and technical skills are valued. This is especially relevant for mathematics students as there are many different careers available and students are not always aware of the variety of mathematical roles in organisations. In addition, the group work element was particularly effective here as the experienced Year 3 students who had studied the capstone Professional Projects module were able to act as mentors and group leaders. The support and reassurance offered by these senior students provided encouragement for others to build their confidence and engage successfully with the activity, while also providing the Professional Projects students with leadership experience. This reinforces the important point that the embedded offer must take priority before any additional activities outside the curriculum are considered. The extra-curricular activities can supplement but should not be the focus of employability skills development – space must be made in the curriculum for embedded employability initiatives and careful consideration must be given in matching these activities to the stage the students are at in their degree experience, and the appropriateness of the specific module(s) where the activity will be introduced.

As identified by the results from the study, a significant draw for participants seems to have been the opportunity to enhance their skills development. When asked to identify the best thing about the challenge, students singled out the experience of giving a presentation and communicating mathematical work to a business audience. This was a novel aspect of the task for most students and the fact that many identified this as a stand-out benefit is very reassuring. Once again, an important element contributing to the success of the presentation element is the placing of Year 3 Professional Project students as group leaders and mentors. They made what could be a very intimidating prospect (giving a presentation) a valuable learning opportunity and were able to share their tips and experiences of this form of communication with their teammates.

In the future, it is hoped that similar activities can be offered to students. As noted previously, there can be more barriers to engagement with extra-curricular activities and so every effort must be made to highlight the potential benefits to students, and to identify a suitable time in the semester when students may have space for the initiative.

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