Using an employer based project to improve the employability of mathematics graduates

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Abstract  
Mathematics undergraduates already have a number of skills that are of high value to the world of work. Unfortunately they are often poor at understanding how these skills might be used effectively in a commercial environment, and in articulating them when going through the job selection process. At the same time, employers are often unfamiliar with what mathematics graduates have to offer. The University of Leicester has devised a third year undergraduate module to improve both the technical skills that mathematics students might need in the work place and their awareness of how to apply them. The key element is an employer related project, in which students spend a significant amount of time working on a specific project with a local employer. In addition, they are given an understanding of how business works, and experience of writing reports for and giving presentations to external clients. As an additional benefit, the University is developing better links with local businesses, and giving them access to the skills of the Mathematics Department and a feel for the ways in which mathematics can help them.

Keywords  
Employability, project based learning, employer based, business management simulation

1. Introduction  
The University of Leicester has, for some years, been striving to improve the employability of its mathematics undergraduates. Many of them become accountants and managers but often they struggle to see how their mathematical skills can be utilised in this new environment. For the past four years, the University has run a second year module for its Mathematics with Management students called Business Applications of Mathematics (BAM), in which students are given real case studies to solve. When they have solved them, they are required to write a report and give a presentation, as if to the manager concerned. Case studies are often constructed or adapted to illustrate the mathematics that is being taught, and are therefore artificial. The case studies for BAM are based on real problems, which means they have traits that students are not familiar with:

- The language used is that of business, not of mathematics;
- There is no indication of which mathematical techniques might be appropriate;
- The data are not necessarily precise or complete.

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Students find them very hard because, while the mathematics in most cases is not difficult, they do not know where to start. Once they get used to the concepts of mathematical modelling, they improve dramatically.

In order to extend the principles of BAM, in 2011/12 the Department introduced a third year Employer-Related Project module. As in BAM, students solve problems, write reports and give presentations about their findings. However, instead of class based case studies, students work on real projects for local employers. As third year undergraduates are not necessarily well prepared for working in a commercial environment, additional preparatory training is also given. This paper describes the experience of running the module in 2011/12, and the benefits to students, local employers and the University.

2. Module Description
Students taking any Mathematics based courses were eligible but it was compulsory for Financial Mathematics and Mathematics with Management students and it could be taken as a 20, 30 or 40 credit module. There were some differences between the various options but, for simplicity, only the 20 credit module is described.

2.1 Aims and Objectives
The aims of the Employer-Related Project were to impart to students:
- An understanding of how business works;
- Specific technical skills that local employers have told us they value;
- Employability skills;
- Practical experience of working on a project with an employer.

The objectives were that by the end of the module there would be:
- Clear benefits to students in terms of future employability;
- More motivated students, which it was hoped would improve overall performance;
- Improved links with local business community and local employers who have seen Leicester mathematics undergraduates in action and been impressed by them.

2.2 The Business Management Simulation Exercise
In order to gain an understanding of how business works, students took part in a strategic level management simulation game, worth 10% of the module marks, run by an external consultant. For this, students were divided into teams, each responsible, as a Board of Directors, for running a company. They were asked to hold formal Board Meetings, with Agendas and Minutes, and to rotate the roles of Chair and Secretary so everyone experienced them. Teams began by preparing a Business Plan and then took a series of annual strategic decisions on finance, investment, personnel, marketing and operations, which determined the success of the company. At the end, each team gave a presentation on what it had sought to achieve, how well it had succeeded and what its members had learnt. Marks were awarded for:
- Business Plans;
- Agendas and minutes;
- Final presentations; and
- A peer review to spot students not pulling their weight.

Marks were awarded on the basis of what students had learnt rather than for winning, but there were prizes for the winners to add a competitive edge.
The business game is realistic, being based on real data, and detailed. No concessions were made for the fact the participants were students (it is normally run as a training tool for aspiring executives in large companies), so they were expected to learn a lot about business in a very short space of time. It is fully competitive, so the outcome for each team is affected by the strategies adopted by their competitors and, crucially, on the ability of each team to interpret and react to developments in the competitive environment.

Students found it very worthwhile. Out of 32 students who responded to a questionnaire, (62% of the 52 participating), 88% said they had found it at least reasonably enjoyable, 91% said they had learnt at least a reasonable amount about running a business and 84% said they thought it would be useful in their future careers; but only 66% thought they had learnt much about using mathematics in running a business. The aspects they liked most were learning how to run a business, the team work, the competitiveness and the realism. Several said they had valued the formality of the Board meetings.

2.3 Technical and employability skills
Previous discussions had identified certain specific skills that local employers value, but that are not routinely taught in the mathematics curriculum, such as high quality skills in Microsoft Excel. Excel is a very powerful tool; if Visual Basic for Applications (VBA) is included, spread sheets can do almost anything a business might want. Despite this, even quite large employers often do not have the in-house skills to take advantage of its full potential. Hence, workshops in the use of Excel (including VBA) were run for students.

To improve their employability skills, students attended workshops run by Bizbuilder, the commercial arm of the Leicester Chamber of Commerce. These included sessions on:

- Understanding business;
- Transferable skills;
- Creativity and entrepreneurship;
- Team work and communication;
- Self-management;
- Team work and communication; and
- Making the most of a CV.

They also attended presentations, in which major employers explained what they look for in graduate recruits, and networking seminars led by consultants such as Deloitte. No marks were allocated to these sessions but attendance levels were very high.

2.4 Employer-based project
The key aspect of the module was a project, requiring about 100 hours of work and worth 90% of the marks, for an external client. Several students could work as a team on larger projects, as long as it was possible to assess each student’s contribution. Projects had to be something the employer wanted done but did not have the resources or skills to do, have a clearly defined outcome that could be assessed, and be capable of completion within the time frame. They could be part of a larger project as long as they were reasonably self-contained. The degree of potential mathematics was unspecified because the employers commissioning projects often did not appreciate the range of possible applications of

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1 For more about the Business Game, see: Training at http://www.bizecon.com/.
mathematics. The areas suggested as appropriate to clients included data analysis, management information systems, demand forecasting, customer and supplier surveys, risk analysis, optimisation of resource utilisation and evaluating innovations.

Students were expected to begin by preparing a project plan and, as in BAM, end with a written report and presentation of their findings to their client. Assessment for the module varied because of the range of projects undertaken but the 90% total mark might be split:

- Project plan: 10%
- IT product or team work: 20%
- Presentation: 25%
- Written report: 30%
- Client mark: 5%

3. Implementation
The workshops were run in the first half of Semester 1 and the Business Game in the second. The launch event for the projects, with both business partners and students present, was held on the same day as the final presentations for the business game so business partners could assist in the judging. This meant they saw the students in action and it was gratifying to see they were very favourably impressed. There was then a speed dating session, where companies could tell students what sort of projects they had available and students could sell their skills. Students undertook their projects during Semester 2.

The range of clients was very wide, both in the size and nature of the organisations covered. The projects ranged from creating a credit score card, through developing an algorithm for classifying people based on shape analysis to geostatistical interpolation of atmospheric gas observations from earth observation satellites.

For the most part, students found the projects immensely rewarding, many putting in far more than the specified hours. The quality of the reports and presentations was, unsurprisingly, variable but the best were truly outstanding. They saw the projects as very much theirs, and this motivated them far more than could have been expected.

4. Benefits
4.1 Benefits to Students
There were clear benefits to students in terms of future employability. They worked on real problems that they enjoyed; they gained valuable skills that they will find beneficial in their careers and that employers will value; and they have had close contact with the world of work. In terms of immediate benefit, one company gave a student a job and another took a student for a summer internship.

4.2 Benefits to Businesses
Businesses benefitted because a positive contribution was made by students, and were very positive about it. Comments included: “We were very impressed with their technical skills, enthusiasm and pro-active work attitude and delighted with the technical progress each of them made. They all exceeded our expectations and made a positive contribution to the work of the group as well as gaining valuable experience themselves”.

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2 It is commonplace to ask businesses if they have any mathematically based projects for students to work on and be told no, when in fact the organisation uses mathematics all the time without realising it. One reason for this is that once mathematical techniques become established in business the users no longer think of them as mathematics.
4.3 Benefits to the University
The University also benefitted. The extra motivation of students, who began to see a real point to their studies in a way they did not before, influenced their overall performance. In 2011/12, the Mathematics Department saw its best results ever, due in no small part due to the additional motivation and enthusiasm of students who now saw more point in what they were doing at University. The Mathematics Department now has much better links with the local business community and employers have seen its undergraduates in action and been impressed by them. This should aid future students in finding work.

5. Issues to Resolve and Next Steps
There are, of course, challenges in running a module of this kind:

- Timing was an issue. Students complained that starting the Business Game in the middle of term meant they did not have enough time for it, particularly at the end when there were deadlines in other modules. Starting the projects at the end of the semester meant that projects did not get away as quickly as they might;
- A uniform assessment scheme was difficult because the companies wanted different sorts of output and the projects varied widely. External examiners were nervous about this so, to ensure the assessment was robust, projects were marked twice within the Department and assessed separately by the external client;
- In some cases, the projects were so technical that Supervisors struggled to understand the students’ work;
- Inadequate communication with companies caused problems in some cases. The degree of commitment required was not always well communicated to them and projects were not always well specified;
- In some cases, there was insufficient monitoring of student progress to make sure that projects did not come off the rails. Students were expected to maintain regular contact with both their client and supervisor but did not always do so;
- The module was costly to run – particularly the Bizbuilder workshops, which were grant funded and would have been unaffordable otherwise.

The University believes this was a hugely worthwhile exercise and is repeating it in 2012/13. Many of the employers are engaging again, so there are more than enough projects for students to choose from (in 2011/12 there was concern that there would not be enough projects for all the students). The lessons from 2011/12 have been learnt, as far as possible. The timing has been modified; the Business Game runs throughout the Autumn Term and the launch of the projects takes place in the middle of it, which means students are better prepared for starting their projects in Semester 2. More care has been taken in the specification of projects, in communicating the requirements to businesses and in ensuring the students’ skills are appropriate. Students are monitored more closely and greater emphasis placed on their maintaining regular contact with the client, to make sure that projects stay on track. Lower cost options are being sought for the Bizbuilder workshops.

The problems of a uniform assessment framework and the highly technical nature of some of the projects remain, and are probably insuperable, but the important thing is what the students learn. In the real world projects are all very different and can run into unexpected difficulties; assessment of them can be to some extent subjective. The important questions are: how do the students respond, and what does the client think of the solution presented or work done? Academic judgement alone can be misleading in these circumstances.