

ENTREPRENEURIAL MATHEMATICS GRADUATES

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ABSTRACT

The university of Ulster is developing a strategy for the introduction of “entrepreneurial studies” into all of its programmes. The Learning Outcomes (LOs) expected of each programme must include the following:

On completion of this programme students will be able to:

- Demonstrate innovative thinking and creativity.
- Demonstrate knowledge of future trends in her or his subject area
- Identify the steps required to research a market for a business opportunity.
- Explain the impact of intellectual property rights with respect to new idea generation and product innovation.
- Describe the component parts of a business plan.
- Demonstrate familiarity with the range of organisational support available to assist with new enterprise development within UU and the local community.
- Demonstrate team building ability.
- Identify the steps required with respect to new company set up and incorporation.
- Identify the key sources of finance available for business start-up.
- Communicate new ideas effectively.
- Demonstrate familiarity with an e-learning environment.

The course team for the honours degree in Mathematics with Computing has devised a curriculum which seeks to develop these LOs in students. The curriculum innovations involved include the provision of two modules - “Mathematical Modelling” and “Statistics for Industry with Entrepreneurship”. It is intended to offer these modules in Semester 4 of the course, i.e. the 2nd semester of Year 2. They will be taught in parallel along with a module of computer science.

The paper starts with a discussion of “entrepreneurship”. It goes on to outline the gradual development of the course over a number of years, and how the required LOs came to be embedded in the course modules. It will indicate how we propose to teach the latest additions to the curriculum, starting in the 2nd semester of 2003/04.

Keywords: - enterprise, entrepreneurship, mathematics, key skills.

1. Introduction

There is a vast literature on “entrepreneurial education” although often it is found under a different name. We will cite just two papers, a few years old, because they give an extensive survey of entrepreneurship education and training programmes; these are the papers by Garavan and O’Cinneide (1994a and 1994b). Many of these programmes are in the context of professional development courses for people who already know that they want to at least try to be entrepreneurs, who have got an innovative idea that they wish to exploit and who now seek the specialist business knowledge required to do it. Such courses would be delivered by departments of business and management or specialist entrepreneurial units established for this purpose. There are also references to aspects of undergraduate teaching involving engineering students engaging in joint entrepreneurial studies with business studies students. We found no references to entrepreneurial mathematics students.

There are three terms, which are used frequently. These are “enterprise education”, “entrepreneurship education” and “small business education”. Sometimes the word “training” is used in addition to “education”. We suggest that it is necessary to distinguish between these; often they are used almost interchangeably and they tend to have different meanings in different parts of the world, notably North America and the UK and Ireland. Garavan and O’Cinneide (1994a) point out that “the term ‘entrepreneurship education’ is commonly used in Canada and the USA, but it is less commonly used in Europe. The preferred term in the UK and Ireland is ‘enterprise’ and it is primarily focussed on the development of personal attributes. The term ‘enterprise’ does not necessarily embrace the small business project idea or the entrepreneur”. This would be our use of the term “enterprise” and it has been used in this sense at the University of Ulster for many years, although things are now changing. Garavan and O’Cinneide go on to define “entrepreneurship” as “independent small business ownership”, and they distinguish carefully between small businesses that have entrepreneurial owners and those that do not. Another term we will explore the meaning and usefulness of is “intrapreneurship”, and we shall look at this in section 2 when we describe the development of the course thus far.

Some people suggest that entrepreneurs are born and not made. Others suggest the opposite. The evaluative evidence of courses which seek to teach entrepreneurial knowledge, skills and attitudes tends to support the latter point of view, and it is widely accepted that knowing about entrepreneurial skills is valuable in itself. It is generally recognised that an “entrepreneurial attitude” is essential to success. Garavan and O’Cinneide (1994a) write, “..this later topic of attitudes, the psycho-social forces of the individual and the cultural context, is of prime importance in influencing innovative and entrepreneurial behaviour patterns” and, as Cool Hand Luke says in a classic 1967 movie, “Boss, I now got my head right!” Hence the inculcation of “entrepreneurial attitude” is something a teaching intervention should strive for.

There is a strong belief that in the future innovative business ideas will come from small to medium businesses managed or owned by entrepreneurs. Since economic growth and national prosperity are goals that most governments wish for their respective countries, entrepreneurial education is encouraged and supported from the highest levels. In the University of Ulster, the move to include entrepreneurial studies in all courses came as an edict from Senate, under the leadership of the vice-chancellor. Additional funds were secured from government agencies to promote the idea through the hiring or seconding of staff with the necessary expertise. The staff appointed to this unit were not to deliver entrepreneurial teaching to each course, nor to devise a global, generic, “one size fits all” module for courses to adopt. They were first of all to win over

staff who felt that entrepreneurial studies were a nonsense for their students, and then to act as a resource person cum advisor who would help academics to devise their own modules for their own courses. These could then be presented in the culture of the particular subject community. Many people did not need to be won over. In particular engineers of all hues, art and design lecturers and others whose graduates make and then sell artefacts, were all keen on the idea. But those who prepared graduates for service in the caring professions like nursing, for example, were up in arms, claiming that entrepreneurial studies were all about “bottom line” management, and this was inappropriate for their students. The mathematics and statistics group was not immediately enamoured by the idea. We felt we were already doing a good job in preparing enterprising graduates for employment and that the idea of a newly qualified mathematics graduate going out and setting up a small business was laughable. It was beyond our experience, our own world picture, and we could see no use for it, nor had we any confidence in our own ability to deliver the required teaching with authority.

But an edict is an edict and we joined in the ensuing debates with the specialist entrepreneurial advisor. We, and even our colleague in the caring professions, came to see the value of what was proposed for our students. We shall discuss this further in section 3 wherein we shall also describe the new developments to be introduced in the near future.

2. Previous development

Between ten and fifteen years ago the course in Mathematics with Computing (then called the honours degree in Mathematics, Statistics and Computing) was heavily influenced by the Enterprise in Higher Education Initiative which was a government agency funded project to encourage universities to produce “enterprising” graduates (TEED, 1989). The University of Ulster received its share of the funding and used it to facilitate staff development. A small number of staff with the necessary expertise were seconded to the Enterprise unit, and each faculty appointed one of its academics as its Enterprise Advisor. The main criterion for appointment was enthusiasm for the idea. Money trickled down to faculty staff to help pay for staff development and pilot schemes.

The EHE scheme allowed universities to develop their own definition of “enterprise” and UU chose to describe an enterprising graduate in terms of his or her personal transferable skills. Skills that have more recently been called Key Skills (Dearing 1997). These are the skills of communication, problem solving, independent learning and group or team work. At this stage there were no edicts, but a sufficient number of academics became enthused by the idea that the scheme worked. Later, the embedding of “enterprise competencies” or key skills became mandatory, with all new courses and all established courses at quinquennial review being required to demonstrate how key skills were taught.

Another influence on the development of our course was the Peer Tutoring Project, again a teaching initiative project funded by government agency. Innovative teaching schemes, which made use of peer learning and self and peer assessment were encouraged. Since learning from colleagues is a feature of industrial environments, and since we sought to develop employable graduates, these ideas also found their way into our course (Griffiths, Houston and Lazenbatt, 1995).

We chose to introduce key skills in a variety of ways and modules. Prominent among these were first year modules on “use of ICT in mathematics” and “mathematical modelling”, a second module on modelling in Year 2, a whole year, Year 3 of the course, spent in a sandwich placement

in industry, and a final year individual Project. In addition students undertook a diet of traditional modules in mathematics, statistics and computing.

In the innovative modules in years 1 and 2, group project work and peer learning were exploited to good effect. For example in the Year 1 module on modelling, students performed several tasks. Working in small groups, students would research a modelling application using suggested references. They would write lecture notes for their colleagues to use to learn the topic and they would give a seminar on the topic. This seminar programme occupied mainly the middle third of the semester. Students needed four weeks to do their research and preparation, and they also needed time at the end of the semester to complete other tasks and to prepare for the written examination which examined knowledge of all of the seminars. The other major task each group was asked to carry out was to do a project on a suggested title. This involved active modelling (as distinct from the study and analysis of existing models), and the writing of a research report. Groups also presented and defended their work at an end-of-term poster session.

During Year 2, besides taking the second modelling module, students would be taught how to write their CV and how to apply and present themselves for job interviews for the placement jobs. Many of these jobs were outside Northern Ireland, and it was either a great adventure or a great trial for them to go and live and work somewhere seemingly far away from home. [Virtually all students at UU live at home or go home every weekend with no more than a ninety-minute journey.]

Student placements were largely in statistical enquiry houses and government agencies, or in some other computing environment where their mathematical skills gave them an additional attribute. Usually they would work at a level suitable for undergraduates, performing tasks that mattered. They were full time employees and had to accept the personal discipline involved. Often they had the satisfaction of having their work praised and used by higher officers in the company. They were supervised by the company and visited by an academic tutor. They received training from the company and they kept a work diary. On return to university, they wrote a reflective placement report which described their experiences living and working in a new environment and which also described the company, its structure and its work.

Our graduates were all employed within three months of graduation and employers usually spoke highly of them when asked for an opinion. We felt we were doing a good job, and, when we looked at the list of Learning Outcomes required by the entrepreneurial studies edict, we felt that we were already meeting what seemed to us to be the most important, those that made them so employable, the key skills of communication, inventive problem solving, team work and independent learning. We felt that they had the right attitude to life, being motivated to go out and get a good job that was satisfying and rewarding. The other entrepreneurial LOs seemed to us to be about setting up as self employed, small business managers or owners, and none of our students was going to do that! Well certainly not at the age of 22 or so.

But an edict is an edict. “Enterprising” was no longer enough; “entrepreneurial studies” were required. Through discussion with the entrepreneurial advisor we came to realise that in a culture like mathematics, where virtually all graduates went into the employ of some company, we saw that it would be valuable to our graduates as employees to have a greater knowledge of the real-world side, the financial side of businesses, both small and large. It would be valuable to them to have an entrepreneurial attitude, even in employment where they might demonstrate “intrapreneurialship”, that is seeking to be innovative and inventive in their employment. Garavan and O’Cinneide say that “entrepreneurs are characterised by innovative behaviour and employ strategic management practices, the main goals being profit and growth.”

3. Entrepreneurial studies

The teaching programme outlined in this section is, today, merely ideas and plans. It will be the second semester of 2003/04 before we get the opportunity to put these ideas into practice, so we have some time to improve our own knowledge base and to prepare suitable learning materials for our students.

The revised course in Mathematics and Computing has one fewer module in mathematics and one more module in statistics. One reason for the change to the course was that since many of our graduates found employment in statistical enquiry businesses, we considered it highly desirable to include more training in the use of sophisticated statistical software packages like SAS.

To achieve this change, we compressed the two mathematical modelling modules, previously taught in years 1 and 2, into one module called simply “Mathematical Modelling”. The new statistics module introduced is called “Statistics for Industry with Entrepreneurship”. Both will be taught in semester 2 of year 2, after a substantial foundation in mathematical methods and statistical theory has been laid. It is at this time that students will be thinking purposefully about their placement year and we believe that is an appropriate time to teach some entrepreneurial studies.

After discussion with the entrepreneurial specialist advisor, it has been agreed that we should teach all the key skills elements of our course in the same way as before, namely in the context of teaching students to adopt the way of life of industrial mathematicians. Problem solving, group working and communication are all learnt in a mathematics environment. It is planned to do this mainly in the new Mathematical Modelling module. Similar teaching and learning methods as are employed at present will be used. There will be student seminars and student project work, but now involving more advanced mathematics and statistics than was possible when the module was taught in Year 1. Emphasis is placed on good writing and presentation skills and on harmonious group work. Some of the early semester tasks will be “course requirements”, in that students must engage with them in order to complete the module. But they will be assessed only formatively, that is, a grade will not be given but extensive formative feedback - including praise where it is earned - will be provided. This is a new venture for us (i.e. not grading and counting every single piece of coursework), but it is a venture that reduces the overall assessment anxiety, and a venture that is being promoted by some educational developers like Gibbs (2001).

The specific entrepreneurial studies are included in the new statistics module. We agreed with the advisor that, for our students, it would be sufficient for them to have theoretical knowledge of small business start-up procedures. We will teach this mainly as “head knowledge” but we expect it to become alive to them during and after their placement. We will expect them, while on placement, to explore with their employing company, the “real-world” aspects of business life. A survey of students returning from placement indicated that several of them found “learning about the work environment and the workings of business” to be one of the best features of placement. Most of the LOs listed in the Abstract are included in this module. Teaching and learning resources are currently available, provided through e-learning packages prepared by colleagues in Business and Management and by the entrepreneurial advisors. It is to some extent, an “add-on” to our syllabus, but it is placed beside material that will be very pertinent to students on placement and in graduate employment, namely: - Questionnaire Design and Analysis, Quality Control, Use of Statistical Databases and Advanced Statistical Software (SAS). The entrepreneurial studies element will be assessed summatively through a case study plus essay, and will look particularly at researching the market for a business opportunity and at setting up a new company.

We can think of only one graduate from our course over the years who could be described as a true entrepreneur, who is now running his own small business and employing at least one other graduate from UU. This man came to us as a mature student in his later twenties, he finished top of his class, he completed a PhD in a mathematical aspect of computer science, and he worked for a few years in the employ of a large software company in Northern Ireland. With the recession in the software industry in recent years the company was downsizing and there was a threat of redundancy. This gave him the impetus to become self employed and to set up a small software company, specialising in a niche market. His profile is typical of many entrepreneurs - a highflying student with some years of employment experience and with an innovative idea to sell. Not all of our students will be able to emulate this graduate, but part of the rationale behind the entrepreneurial studies programme is that more students will have the necessary knowledge and may be inspired with the necessary innovative idea or ideas.

4. Conclusions

The most valuable asset a student possesses is himself or herself, but they do not always appreciate this when they leave high school. Many of the students at UU come from working class social backgrounds and may be the first generation in their families to go to university. Many would come from an environment where unemployment is the norm and social security benefits and casual work are the main income sources. Such students have to learn to value themselves, their talents and the opportunities higher education affords them. Many are frightened by the prospect of borrowing money to complete their education; they work long hours at pumping petrol and stacking supermarket shelves in order to stay out of debt, and thus they leave themselves with less time for study and normal student socialising. Being able to create a personal business plan for themselves might help students in this situation. Setting themselves goals and ambitions to achieve should help motivate them to learn and not to be afraid of borrowing money to invest in themselves and the possibilities of their own bright future. It might help them to get their “head right”, to adopt the attitude needed for success.

In this paper we have described the situation at the University of Ulster regarding the university-wide teaching of entrepreneurial studies. Students are expected to take at least half a module’s worth of this subject (about 8% of one year’s total). It is desired that these studies be embedded in mainstream subject teaching, rather than being a simple add-on half module. The course in Mathematics and Computing, which we have described, seeks to achieve this. It is based on our previous good experience of embedding the teaching of key skills and it makes use of expertise and resources available elsewhere in the university. We shall report at ICME-3 how successful (or not) we will have been.

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