REFERRED PAPER

PREPARING STUDENTS FOR THE WORLD OF WORK: AN EVALUATION OF UNDERGRADUATE WORK PLACEMENTS BY STUDENTS AND EMPLOYERS

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ABSTRACT
The importance of students putting theory into practice is well recognised in statistics education and there is an increasing emphasis on developing skills such as questioning, communication and interpersonal skills. Appropriate work placements for mathematics and statistics undergraduates, integrated into their degree programme, have an important role to play in the development of both technical and personal skills. The objective of this study is to report on the evaluation of work placements by the most recent cohort of Mathematics and Statistics degree students in the University of Limerick from 2009/10 (n=20). A summary of the qualitative comments from students, ratings and overall assessment are given together with an evaluation from their employers of their performance and the benefits of the work placement programme. This feedback provides useful information for faculty on how well students are prepared for the world of work and what areas could be improved on.

INTRODUCTION

There is a well recognised need to balance theory and practice in statistics education and an increasing emphasis on "practice of important techniques, problem solving, application to everyday situations, investigative work" (National Research Council of the USA, 1991). Practising statisticians stress the importance of problem formulation, questioning skills and the use of background information. The importance of context in statistical practice, the key role of descriptive data analysis and recognising the iterative nature of statistical work is also highlighted (Chatfield, 2002). Integrating role plays of consultations and practical experience of consulting into statistics education gives students an important opportunity to develop these skills (Jolliffe, 2006; Taplin, 2007). Jolliffe (2006) stresses the importance of communication, listening and questioning, interpersonal, data management and advertising skills for statistical consultancy including being proactive in promoting statistics. However, Taplin (2007) recognises that including consultancy experience in the classroom is not the same as real work experience. Role plays of consultations and examples of consultancy sessions cannot fully replicate the experience of being part of an organisation, the role that statistics plays in that organisation and work place culture. Appropriate professional experience allows students to appreciate the constraints of a real life problem and having to work within those limits. The importance of communicating with non statisticians in multidisciplinary teams is also highlighted.

Integrating an appropriate work placement into undergraduate education has obvious advantages. Employers can benefit from the experience of hiring students on placement by getting the opportunity to undertake specific projects or other work without adding a permanent payroll cost. Students are often enthusiastic, energetic, offer specialist skills and are eager to work on complex or routine tasks so work placements can be a cost effective and flexible solution to recruitment needs. It also gives employers the opportunity to vet potential graduates first-hand over an extended period in a real work environment. Feedback from employers suggests that graduates who have undertaken a period of work experience during their degree gain many skills essential for success at work e.g. maturity, the ability to work as part of a team, communication and interpersonal skills.

Work placement can also offer significant benefits to students. It can help to build students' self-confidence by working with others, putting their academic knowledge into practice, improving their employability and broadening their knowledge base, making decisions about their future career and learning how to fit into an organisation.

WORK PLACEMENT AT THE UNIVERSITY OF LIMERICK

All undergraduate students at the University of Limerick are required to undertake relevant work experience, normally of eight months duration, as part of their degree programme. The University places 2,000 students annually, making it one of the largest placement programmes in Europe. Some 1,600 employers participate in the programme annually and about 75% of these employers also employ graduates of the University. A higher proportion of University of Limerick graduates go directly into employment after graduation (8% higher than the national average) and their starting salaries are also higher. For many employers, their involvement in the programme represents the first point of contact with the University and over 700 employers visit the campus every year. Some 30% of placements are secured internationally; primarily in Europe, North America and Asia. Students preparing to go on placement complete an online CV which outlines their education and experiences to date. Potential employers complete an employer registration form giving details on their organisation, the number and nature of the positions they are offering and the degree courses they would like to recruit from. The Cooperative Education Division in the University matches the students to the employer and identifies a number of suitable students who are then interviewed by the employer. Students are paid on placement and a minimum salary is recommended to cover living expenses.

The most recent cohort of Mathematics and Statistics students (academic year 2009/10, n=20) were placed in industry in their third year of a four year degree programme. The degree programme is a broad based mathematics degree including calculus, discrete mathematics, probability, linear algebra, mathematical modelling, statistics, operations research, numerical analysis and computing. Students have the option to major in mathematics, statistics or computing in the third and fourth year of the degree. Students were placed in a wide variety of sectors (Table 1) and most placements were for an eight month period from January to September. Some students were placed in sectors where they were under the direct supervision of an experienced statistician but the majority of students were in a general work environment and were part of large multidisciplinary teams. 2 (10%) of the students were placed abroad, the rest were placed in Ireland. The companies included large multinationals, biomedical and electronic manufacturing companies and IT service providers.

Table 1 Sector of employment

Sector	**n (%)**
Financial and insurance services	7 (35%)
Information and software services	5 (25%)
Manufacturing	3 (15%)
Statistical Consulting	3 (15%)
Media	1 (5%)
Agriculture	1 (5%)

EVALUATION OF WORK PLACEMENTS

Work placements are an academically accredited part of degree programmes in the University of Limerick and students are graded on a pass-fail basis. The grade is decided by a faculty member and is based on the employer's evaluation of the student's performance and the student's written report on their placement.

A faculty member from the Department of Mathematics and Statistics was assigned to each student and during the course of the placement, visited the student on site. The purpose of the visit was to discuss the work assignment and the student's progress with both the student and his/her supervisor, and to deal with any problems or issues that had arisen during the placement. These visits can also be useful in identifying future placements or graduate positions with employers and can provide a first point of contact between academia and industry for future collaboration and research.

Students were asked to rate the relevance of their placement to their degree course on a five point scale where 1=unsatisfactory and 5=excellent. The median rating from the students was 4 (IQR=1) indicating the success of the University in engaging with employers and providing appropriate placements for these students. Qualitative comments from the students indicated that the most relevant areas to their placement which were covered in their degree course were questionnaire design, descriptive statistics, specialist software such as SPSS, R programming, Excel, problem solving skills, and general computing skills. The importance of putting theory into practice was highlighted by students. For example, one student wrote "As my course is quite technical, I am really having the opportunity to implement what I have learned in college". Students also had the opportunity to learn from more experienced colleagues, as expressed by this student's comment: "I am encouraged to investigate any problems experienced … before approaching a more experienced staff member".

Specific projects carried out by students during their placements included customer surveys, social networking research, labour cost analysis, data collection for funding applications, analyses of performance indicators and investigating the relationship between performance indicators and economic activity, data entry and analysis of patient satisfaction surveys and database development. Students were asked if the placement helped them to clarify their career objectives on a five point scale where 1=not at all useful to 5=extremely useful. The median rating was 4 (IQR=1.5) again indicating a generally positive response from the students. One student wrote "It has given me a great interest in pursuing a career in this area from a more mathematical perspective" while another student commented "I have a clearer idea of what I'd like to do when I'm finished my degree" and "I will use this knowledge when making decisions concerning my career in the future". The benefits of exposing students to a real working environment are also clear in terms of developing maturity and responsibility. For example one student wrote "I am given responsibility for carrying out daily tasks and get to see firsthand the effects of my actions and mistakes" and another student commented that " my team have given me responsibility for keeping key performance indicators up to date".

Employers were asked to rate the performance of students (n=20) in a number of key areas at the end of the placement on a five point scale where 1=unsatisfactory (never demonstrates this ability/does not meet expectations and 5=Excellent (Always demonstrates this ability/consistently exceeds expectations. A summary of the results for some of the key areas is given in Table 2.

Table 2 Results in key performance areas

Key performance areas	**Median (IQR)**
Ability to learn (asks pertinent and purposeful questions)	5 (1)
Problem solving skills	4.5 (1.75)
Demonstrates an analytical capacity	4.5 (1)
Technical knowledge	4 (1)
Written communication	4 (0)
Verbal communication	4 (1)

The evaluation from employers was generally positive with many expressing the desire to recruit students again. One employer commented that the student had made a "very valuable contribution to the group" while another wrote that the placement was a "good investment – brings fresh ideas and recruitment of future graduates made easier". Specific comments on the students included "excellent attention to detail" from one employer, "very flexible and keen to learn" from another and "well motivated and willing to learn" from another. It is encouraging to see the strong rating of students' problem solving, questioning and analytical skills from employers – key skills for a practising statistician. Some employers noted that students needed to focus more on solving issues on their own and taking the initiative themselves and others noted that occasionally students had difficulty interacting with others.

Students are required to submit a written report on their placement on their return to college. The report forms part of the evaluation of the placement and requires the student to link the placement with their studies. The report includes a brief history of the company including details of the product/service provided, the organisational structure of the company in particular the department in which the student worked, the nature of the work carried out by the student and their personal development. The report has to be signed by their employer and is then graded on a pass/fail basis by the faculty member who visited them on site during their placement. Students also carry out a pre and post placement assessment of their ability in the core skills that employers look for in graduates including problem solving skills, organisational awareness, interpersonal/ teamwork and ICT skills. The pre and post assessment helps students to recognise the skills and knowledge they have developed during their placement, identify gaps in their skills/knowledge and plan to bridge these gaps. It also provides a record of their skills for effective job applications and in some instances professional recognition. Mathematics and statistics degree students reported increases in their ability after placement across all the core skills but particularly in the areas of communication and problem solving skills. Rating of their communication skills by students increased by 31% on average (from a baseline of 51%) and rating of problem solving skills increased by 14% on average (from a baseline of 48%).

Students also have the opportunity to bring back data and problems from their placement for their final year project. The final year project is a research project which is supervised by a faculty member and represents one fifth of the credits for the students' final year. Bidgood (2009) noted that projects which have come from work placements are often the most successful final year projects since students get an appreciation of the relevance of statistics to real life and an interest in working with genuine data on a real world problem. A similar experience has been found at the University of Limerick where final year projects that arise from placements continue the connection with industry for the student and can often result in graduate employment.

CONCLUSION AND FURTHER RESEARCH

Appropriate work placements for mathematics and statistics undergraduates provide an important link between theory and practice and give students an opportunity to develop key skills necessary for a practising statistician i.e. communication and problem solving skills, interpersonal and questioning skills. Harraway and Barker (2005) suggest that the teaching of statistics at university level has be informed by what graduates do with their statistical knowledge after graduation and that this type of information can be useful for planning academic curricula. A work placement programme also links academia with industry and can ensure the relevance of academic programmes. Evaluation of work placements is essential, from both a student and employer perspective, to ensure that the placement is appropriate for the student's degree programme and represents a good investment by the employer. Data for a small sample of mathematics and statistics degree students is presented here and currently all evaluation forms by students and employers are paper based. From 2011 onwards, evaluation will be computer based which will facilitate data analysis on a more extensive database and allow for easier comparisons across years and courses. A qualitative and quantitative analysis of a more extensive database, comments and reports from students and employers will provide useful information on how well we prepare our students for the world of work, what technical knowledge is of most use to them, where industry is using this knowledge and what personal skills are most useful for practising statisticians.

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