HELPING STUDENTS PREPARE FOR THEIR FUTURE WORKING LIVES

Dr Penelope BIDGOOD
Kingston University
United Kingdom

Good course design, informed by research in statistical education and external influences should include some employability skills, whilst maintaining academic standards. At one UK university, the statistics programme was devised to include development of both transferable and subject specific skills that help to prepare students for their future working lives. Students have opportunities to gain both oral and written presentational skills in addition to developing their statistical reasoning and thinking skills. A final year project enables students to work independently on an area of statistics which is of particular interest to them. Some have sourced such projects from their placement year (or part-time jobs), providing an excellent opportunity for them to apply their statistical knowledge to real life applications, whilst needing to present their results in a form that is acceptable to the workplace.

BACKGROUND

Changes in statistical education at tertiary level have been informed by research which increasingly emphasises statistical understanding, thinking, reasoning and literacy. "Statistics educators need to determine what it is they really want students to learn, to modify their teaching according to suggestions from the research literature and to use assessment to determine if their teaching is effective and if students are developing statistical understanding and competence."(Garfield, 1995) Moreover, statistical investigations and modelling, the use of real data in context and a problem solving approach, all influenced by technological advances, help students to acquire a modern and balanced view of the applied as well as the theoretical aspects of the discipline.

Whilst much work has been done on statistics as a service course to other disciplines, here the focus is on specialist students. Curricula for more mathematically able students were considered by Rossman and Chance (2002) who developed materials to introduce such students to statistical concepts, methods and theory through a data-oriented, active learning pedagogical approach.

This paper describes the curriculum designed for those taking statistics with one other subject in a joint degree programme at a particular university in the UK. To give some context, the mission statement of the university was " To provide career-related higher education, advanced training and research for the development of individuals and organisations in support of the economy and society" with an objective "… enabling individuals from a variety of backgrounds, ages and experiences to fulfil their lifelong learning aims" by providing wide access to "… quality courses to meet the needs of the employment market"

In agreement with Begg at al (2004) the curriculum is designed to build upon the students' backgrounds, be strongly related to data, contribute to the students' development in statistical thinking, take account of current educational and statistical practice, and provide a strong basis for future statistical learning. Transferable, or key skills are also incorporated into the curriculum so that, for example students will have opportunities to gain presentation skills, both written and oral, and to work collaboratively which will be important in their future working lives.

Two aspects which give students opportunities to develop these skills as well as their statistical expertise are the work placement year and the final year project. The former is an

optional year spent in industry, business or government department, taken between the second and third years of the degree programme. The project is part of the degree programme and is an extended, individual piece of research or scholarship, undertaken under the supervision of a member of staff. Over the years several students have brought projects back from their placement year, in which the employer has suggested a "real-life" problem on which students can work. This of course gives the student a good opportunity to apply their statistical knowledge and skills to a problem of direct interest to the employer; students also need to be able to present their work in a form acceptable to the workplace, thus using many of the transferable skills developed during their degree programme.

THE STATISTICS PROGRAMME – OBJECTIVES AND STRATEGIES

The statistics programme described here forms part of a joint degrees programme. In common with most British universities, statistics is not offered as a full degree but can be combined with, for example, Business Studies, Computing, Economics, Environmental Studies, Geography, or Mathematics in major, minor or half mode being five-eighths, three-eighths or half of a full degree programme, respectively.

The statistics curriculum needs to take into account the diversity and background skills of the incoming students. All entrants will have studied some statistics at school, at least to General Certificate of Secondary Education (GCSE) stage. In this the statistical problem-solving/data-handling cycle covers, within the mathematics syllabus, presentation and analysis of large sets of grouped and ungrouped data; scattergraphs, correlation, lines of best fit and their interpretation; measures of central tendency and spread; experimental and theoretical probabilities of single and combined events.

Despite the statistics programme described here requiring higher levels at GCSE mathematics, it has been found that no prior knowledge of statistics can be assumed. This is in line with findings by Harraway (2002) reporting that on a biostatistics course, prior knowledge of statistics from school had no effect on performance.

Similarly to good practice in curriculum design, as advocated by MacGillivray (2004), throughout the programme, emphasis is placed on the applications of statistics, including practical work using computer packages, whilst retaining the necessary theoretical underpinning. One of the strengths of the programme is the division into two parts – in the first half students take core modules which ensure that they have a firm foundation in the discipline, whilst the second half consists of option modules, which enables students to develop their own interest and expertise.

The core statistics modules address three themes:-

- Basic probability theory and distribution theory
- Data analysis including the use of statistical computer packages
- Basic ideas of statistical modelling

There are two core modules, Regression Modelling and Statistical Distributions, in the first semester of year 2, each of which develops themes met in the first year. Regression Modelling, extends knowledge of simple linear regression to multiple linear and logistic regression; here also students learn to use SAS. In Statistical Distributions, students gain further knowledge of discrete and continuous distributions, including joint distributions and parameter estimation.

Thereafter, all modules are options, enabling students to build their own programmes of study as their interests and abilities develop. In the second semester of the second year, currently, these options are Experimental Design, Medical Statistics, Operational Research Techniques or Databases, which may be chosen to complement the other subject studied; for

example Operational Research techniques might be a good choice for Business Studies students or Databases for Computing students.

All taught modules in the final year are options so that students can extend their own interests; some include those offered in the second year, so that students have a further opportunity to take them. The additional modules offered are Stochastic Processes, Time Series and Forecasting Methods, Mathematical Programming, Stochastic Modelling in Finance, Further Inference & Bayesian Methods and Multivariate Methods. There are also project modules, which may be solely statistics-based or of an interdisciplinary nature on a topic which draws on the integration of both disciplines studied.

The learning, teaching and assessment strategies seek to ensure that students learn actively and effectively, thus laying the foundation for future careers and/or further study. The strategies reflect the need to develop a broad range of technical skills, with the ability to apply them appropriately and the requirement to achieve coherent progression in statistical reasoning abilities, taking into account student backgrounds and potential employer requirements. Students should acquire a sound understanding of some important areas in statistics and the transferable skills expected of modern-day undergraduates.

There is a higher level of contact at level 1 (5h per module per week) to provide initial academic support and students are encouraged to develop as independent learners as they progress through their degree course, culminating in a project which is an extended piece of individual work. Students are expected to develop their skills, knowledge and understanding through independent and group learning, in the form of both guided and self-directed study.

Key skills are integrated into the statistics programme, so that students have opportunities to gain a wide range of transferable skills that are developed through the levels. The skill areas identified are communication; numeracy; ICT; teamwork and independent learning.

WORK PLACEMENT

The sandwich, or work placement year is an optional element in the programme, taken between levels 2 and 3. Students who choose the sandwich mode will spend a minimum period of 36 weeks in an approved placement in industry, business or government department.

Students are told that, during the placement, they will be expected to:

- Apply knowledge and skills to real applications and related areas.
- Demonstrate a range of "key skills" such as team work, time and project management, oral and written communication.
- Participate constructively in an extended programme of work and develop practical skills appropriate to the area of work.
- Participate in discussions concerning your work and contribute ideas as appropriate.
- Prepare an extended written report on your placement experience

Assessment for the placement year is on a pass/fail basis and is based on:

- The successful completion of a 3 month probationary period;
- The content of a log book maintained throughout the placement year;
- The report submitted by the academic tutor on completion of each visit;
- An Employer Assessment Report on your performance from your employer;
- A detailed Placement Report compiled by the student on completion of the placement period.

These criteria, whilst designed for all degree subjects, link closely with the aims, objectives, teaching, learning and assessment strategies of the statistics programme and to what employers require. Employers are clearly looking for both subject and key skills, as

shown by the following extracts from some recent examples of work placement advertisements.

(1) You will undertake a variety of training to improve both technical and personal skills. The placement will enable you to understand the background and statistical methods important in drug development. You will analyse data by writing programs in SAS or using other statistical packages, working in close consultation with professional statisticians and learn how to interact effectively with colleagues and customers

(2) Applicants should have strong analytical and problem solving skills. … (they) will gain a wide variety of experience…

(3) Training and experience in the use of spreadsheets (Excel), word processing (Word), databases (Access), presentations and graphics (PowerPoint), will also feature highly in these posts. …developing their interpersonal and team working skills, and improving their analytical / numerical and research skills.

(4) These positions are suitable for students undertaking a maths/statistics or computing degree. A working knowledge of SAS (especially data manipulation) is advantageous, but not essential. Successful students should display good analytical and communication skills.

(5) (You) will gain a good experience of the practical application of statistics in a process development environment. The successful applicant will be involved in a new and innovative project, which will drive the business forward. The main duties of the role will be the systematic collection and interpretation of data.

THE FINAL YEAR INDIVIDUAL PROJECT

A particularly important component of the degree is the project which requires a combination of statistical understanding and applicable skills, building upon the taught modules that precede it. The project helps in preparing student for their future working lives by including a balance of technical statistical skills, the ability to comprehend and model in contexts that may be unfamiliar, analysis and interpretation, communication and presentation. The broad aims of the project are twofold- to give students the experience of undertaking some personal research and/or scholarship in a branch of statistics alone, or in combination with the other field of study and to develop their independent learning and other key skills. The idea of an independent piece of work is important here – students have opportunities in other modules to develop group working skills.

The problems tackled may be of an open-ended nature, allowing students to increase their knowledge of statistics or by studying a topic in greater depth and/or by applying techniques learned in a new situation. The emphasis is on applicability, putting statistics into context and allowing students to connect various pieces of knowledge together in a practical way. "Project work is a method of allowing students to make to use what they have learned in statistics classes in a practical context. It is this practical application of projects that make them such a useful part of the learning process" (Starkings, 1997)

The learning outcomes for the project module at the author's own university, are that students should be able to carry out a literature search; devise and write a concise plan of a proposed research project or dissertation; undertake an investigation of the planned topic and compare the outcomes with the original proposal; produce a well-structured written report; give an oral presentation or answer questions clearly and concisely in a structured interview about their work; demonstrate that they can use IT skills; demonstrate their knowledge of computing skills if appropriate.

Students will be assessed by their development and progress on the project, the written report of the project outcomes and by an oral examination. As such the assessment here will place a greater emphasis on ability to plan work, manage time effectively, and research background information. There are interim assessments too, for example monthly logs of work done; interview and draft chapter at about the half-way stage. Although these are not allocated marks per se, 20% of the final mark is given for "development", which takes these tasks into account as well as attendance at various workshops and meetings with

supervisors. These interim occasions give opportunities for advice and comment, giving students time to reflect on the feedback they receive, make adjustments, and try again.

Snee (1993) argued that we can help students better learn statistical thinking and methods by focusing the content and delivery of statistical education on how people use statistical thinking in real-life situations. This is particularly true of project topics brought back from work placements, some examples of which are:

(1) Work placement with a large pharmaceutical company. The project was of direct interest to them – requiring the student to look at various regression techniques to confirm or otherwise that their current method was identifying the ”best” model; if not to find a better model of the data. This involved the student in learning statistical methods (non-linear regression) beyond the taught course. However, the study was constrained by the company's demands, for example, not wanting the student to look at methods beyond regression techniques. Hence the student was only partially successful to achieving the aims of the project. Nevertheless, he obtained a post with the company on graduation and is still with them

(2) Working at a veterinary laboratory on data on scrapie, a disease found in sheep. The student had to learn a new statistical package, which was the standard for this company, as well as extend her statistical knowledge beyond that in the taught course. The written project report was judged to be good, as it clearly indicated that the student had appreciated the complexities of the disease and the statistical methodologies encountered.

(3) Work placement in the statistical unit at the headquarters of a large supermarket chain. The student so enjoyed the placement year that she returned to the company on graduation; she had also kept very much in touch during her final year, visiting her former colleagues to discuss the progress of her project. This involved using SAS (the company's preferred package) to analyse sales data using time series methods to forecast daily trading

(4) Data were provided by a building society. This was a first class student who, during the time developed two models, the first of which was adopted by the company and the second was used for comparison. Again the student learnt some statistical theory and skills beyond the taught programme.

These all indicate that students have been involved with “real-life” problems and genuine data and the application of their statistical technical and reasoning skills has been in a worthwhile situation. Feedback from students indicates that they appreciated these opportunities and found the projects more interesting because they had arisen from genuine circumstances.

CONCLUSIONS

Statistics presents its own challenges for teaching, learning and assessment, particularly with the growing recognition of, and research in statistical thinking and conceptual understanding. Rather than focussing on statistical skills, procedures and computations, students are encouraged to reason statistically. Thus there is an increasing emphasis on the collection and exploration of data, in context and the interpretation and communication of results. (Ben-Zvi and Garfield, 2004)

Good curriculum design should enable students to achieve these goals. At the author's own university, the statistics programme was devised to prepare students for the many opportunities in further academic or professional studies, or for employment in industry, the Government or business. Statistical skills and knowledge are developed throughout the programme, together with the key skills and computing expertise required of the modern graduate.

The final year project, as a sustained, individual piece of work on a topic of the student's own choosing, is regarded as a particularly important component. It is often the topic that students can discuss at interviews and which staff can comment on in references.

Some of the more successful projects have been those which students have brought from work placements as this gives then an appreciation of the relevance of statistics

to real-life and an interest in working with genuine data on a real problem. All such students have said that they have enjoyed the experience and found it worthwhile.

REFERENCES

Begg, A., Erickson, T., Macgillivray, H. and Matis, T. (2004) Working Group Report on Statistics Curriculum: Content and Framing. In Burrill, G and Camden, M (eds) *Curricular Developments in Statistical Education*, Voorburg, The Netherlands, International Statistical Institute

Ben-Zvi, D. and Garfield, J.B. (2004) Statistical Literacy, reasoning and thinking: Goals, definitions and challenges. In D. Ben-Zvi and J.B. Garfield (Eds), *The Challenges of Developing Statistical Literacy, Reasoning and Thinking (*pp 3-16) Dordrecht, the Netherlands: Kluwer

Garfield, J. (1995) How Students Learn Statistics. *International Statistical Review*, **63**, 1, 25-34 International Statistical Institute

Harraway, J., (2002) Factors Affecting Performance in a University Service Course on Biostatistics: An Update. In B Phillips (ed) *Proceedings of the Sixth International Conference on Teaching Statistics*, Cape Town, Voorburg, the Netherlands, International Statistical Institute

MacGillivray, H. (2004) Coherent and Purposeful Development in statistics across the Educational Spectrum In Burrill, G and Camden, M (eds) *Curricular Developments in Statistical Education*, Voorburg, The Netherlands, International Statistical Institute

Rossman, A and Chance, B (2002) A data-oriented, active learning, post-calculus introduction to statistical concepts, methods and theory. In B Phillips (ed) *Proceedings of the Sixth International Conference on Teaching Statistics*, Cape Town, Voorburg, the Netherlands, international statistical Institute

Snee, R (1993) What's Missing in Statistical Education? *The American Statistician* Vol 47

Starkings, S. (1997) Assessing Student Projects in *The Assessment Challenge in Statistics Education*. Gal and Garfield (eds.) IOS Press.