

Preparatory and Bridging Courses in Statistics

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1. Introduction

In this paper we look at preparatory and bridging courses in statistics at the interface between secondary and tertiary education. We include discussion about similar mathematics courses which contain a probability and statistics component.

Preparatory and bridging courses are defined to be those that fill a gap between the knowledge, skills, and attitudes of students wanting to enrol at a university, and the actual requirements for a tertiary course. Although the terms are sometimes used interchangeably, it is useful to distinguish between them. Preparatory courses tend to be taken over a longer period - typically half a year or a year - at the rate of a few hours per week. They are usually taken by students who do not yet have tertiary entrance, but are hoping to apply for a university place on the basis of successful completion of the course. Bridging courses, on the other hand, tend to be taken over a shorter period - typically a few weeks of intensive study - by students who already have tertiary entrance but have a recognised deficiency in some area of study.

The most important factor in the growth of preparatory and bridging courses in statistics is the changing nature of tertiary education in Australia. Until several decades ago, most students finished their education at age 16 in middle high school. Relatively few students took the last two years of high school, and only the best of them went on to tertiary studies at a university. Indeed, the last two years of high school were seen as a preparation for tertiary study, and were only taken by students with aspirations in that direction.

Twenty years ago only about 30% of students completed the full six years of high school. Over the last ten years there has been a steadily increasing proportion of students completing the last two years of high school in Australia and there has been a corresponding increase in the numbers going on to university study. There have been changes to both high school and university mathematics syllabuses during this period in order to cater for these extra - generally less able - students. Despite this, more and more of them find that the level of mathematics which they have studied at school is

inadequate for the tertiary courses they would like to study. Bridging courses have been established in response to this problem.

Another factor in the changing nature of tertiary education concerns students who do not progress straight from school to university. Over the last decade, under various equity and access provisions encouraged by government policies, universities have been taking a growing proportion of their students from other groups: mature-aged, disadvantaged, special entry, and overseas students. This in turn has led to a greater need for preparatory and bridging courses to give such students a better chance of success in their tertiary studies. Enrolment data from universities in Sydney show that between 70% and 80% of students progress straight from school; the remainder are using some non-standard method of tertiary entrance.

In a recent report, Trigwell and Corrigan (1989) examined the situation at the University of Technology, Sydney (UTS). They pointed out that mathematics is the subject area that causes most problems with prior knowledge for students at UTS (and, in fact, at most other Australian universities). Students have been enrolled, some through special entry schemes, without adequate mathematics background into even such obviously numeracy-based subjects as engineering. Not surprisingly, Trigwell and Corrigan recommended a comprehensive bridging programme in mathematics at UTS, and this is already being implemented.

The previous factors have been responsible for the growth of preparatory and bridging courses in all areas of numeracy and literacy. In addition, some factors pertain specifically to statistics and its relationship with other tertiary subjects.

The subject of statistics has grown in importance to the point where educated numeracy is seen to include the basic ideas of descriptive statistics, a rudimentary knowledge of probability, and at least an appreciation of the fundamental method of inferential statistics. Thirty years ago, few university courses in Australia - except courses in mathematics - included any statistics. Nowadays, tertiary courses in psychology, economics, education, and medicine, to name only a few, include a substantial component of statistics. Most students coming straight from school can cope with this new subject without too much trouble. Mature-age and other special entry students, as well as the less well-prepared students from high school, usually find that they need a preparatory or bridging course in statistics before they have a reasonable chance of successfully completing first-year tertiary courses in these areas.

Specific target groups of students can be listed in the following categories:

- (i) *School students:* Although only basic descriptive statistics and probability are taught in New South Wales high schools, most students are able to handle a first-year statistics course. Some students, however, require bridging courses to raise their mathematics to the level necessary for entrance into the course of their choice.
- (ii) *Mature-age students:* Such students often have a weak mathematics background, and much of that may have been forgotten. Preparatory courses are useful to increase their knowledge, confidence, and study skills. Statistics is a particularly useful subject for them to study; it teaches them much about numeracy without the discouragement of having to go back to material covered in the primary school.
- (iii) *Students with a non-English speaking background:* Many Australians did their

schooling overseas, and many others have been brought up in homes where English is not spoken. These students require preparatory or bridging courses in statistics which focus on the linguistic and cultural background and increase their confidence in studying in a new language.

- (iv) *Students from disadvantaged groups:* Many groups can be identified as disadvantaged in some way, for instance, minority groups such as Aborigines, refugees from other countries, or people with physical disabilities. Such students may require preparatory or bridging courses which take particular account of their disadvantages.
- (v) *Overseas students:* Increasing numbers of students come to Australia for the purposes of tertiary study. They are often very able mathematically, but require preparatory or bridging courses which provide an orientation towards the local cultural situation and stress the language background required for successful study.

2. Characteristics of preparatory and bridging courses

Preparatory and bridging courses in statistics are concerned with filling gaps between: the statistical knowledge and skills of enrolling students and the requirements of a tertiary course; students' conception of the subject and its actual nature; students' level of confidence and study skills and those required by a tertiary course; the linguistic and cultural background of students and the level of language and background cultural knowledge required by a tertiary course; students' attitudes to and experience with appropriate technology (especially calculators and computers) and their necessary use in a statistics course.

Such courses are necessary because students who do not manage to fill these gaps have a poor prognosis in tertiary courses. Remediation *during* tertiary study is typically unsuccessful, although it is more likely to succeed when backed up by continuing support from a learning centre (see, e.g. Kurz (1989) and Barnes (1989)). Students already have a high workload, so extra tutorial work is impractical and often brings about a crisis of confidence as students realise the enormity of the task facing them.

However, preparatory work need not always be undertaken in the form of a traditional course of instruction. There are many alternatives for preparatory and bridging activities. These include orientation programmes for new students, diagnostic testing, bridging packages of individual study material, guided study in a learning centre, and extra consolidation courses *after* the semester's work. Trigwell and Corrigan (1989) discuss these options in the context of the situation at the University of Technology, Sydney.

We now examine the content of preparatory and bridging courses in statistics. On the surface, this is much the same as in any first course in statistics, namely, descriptive statistics, basic probability, and at least an introduction to inferential statistics. However, the preparatory nature of such courses enables the emphasis to be placed on introducing students to the ideas and concepts of statistics at the expense of content - which will be covered in detail in their first tertiary courses.

The difference between standard first-year courses in statistics and preparatory and bridging courses can be illustrated by listing some of the features of the latter based on successful courses we have run in Sydney.

- (i) An introduction to or revision of *basic* mathematics (arithmetic and introductory algebra). This is best combined with an introduction to the use of an electronic calculator, which quickly leads to an increase in mathematical confidence. It is surprising how little mathematics students *need* to know during the early stages of a statistics course, and how much they can pick up during such a course.
- (ii) An introduction to the use of a statistical package on a computer. This can help people without a strong mathematics background to concentrate on the essential ideas and techniques of statistics. It is also useful as a preparation for the use of computers in their statistics courses. Statistical intuition is developed and assisted by the easy access to graphical information provided by a computer.
- (iii) A more contemplative and philosophical approach; for instance, discussions on the interpretation of probability and of the nature of deductive and inductive inference. These are often neglected in a typical first-year statistics course, but are very important for a deeper understanding of the nature of the subject.
- (iv) A reliance on experimentation and practical work in teaching; for instance, simple probability experiments such as Buffon's needle, and simple experiments in sampling from a finite population.
- (v) Teaching of some topics using a simplified approach. For instance, the normal distribution can be presented and used with z-scores of only 0, ± 1 , ± 2 , ± 2.5 and ± 3 . Approximate t-tests can be presented using 95% and 99% confidence intervals consisting of estimate plus or minus 2 and 2.5 standard errors, and the basic concepts of hypothesis testing can be taught using this approach.
- (vi) Sections of the course focus specifically on linguistic and cultural problems. For instance, the language of probability - the terminology of chance events and gambling and the various phrases representing inequalities that are often found in probability questions. Another example is cultural attitudes to learning; for instance, the relative passivity and acceptance of authority often shown by students with a traditional Asian upbringing.
- (vii) Teaching techniques that are more appropriate for adult learners, people with low confidence in their educational abilities, and people with specific deficiencies; for instance, cooperative learning techniques and sessions on study skills and on increasing confidence.
- (viii) Careful tailoring of the teaching approach to suit the target group, possible since such courses tend to have smaller numbers of students than typical first-year lecture groups.

We turn now to resources needed for preparatory and bridging courses in statistics. Any textbooks used must be aimed specifically at the secondary-tertiary interface. It is very discouraging for adult learners to use school texts, even for revision of basic mathematics or for descriptive statistics, and they are often written in an inappropriate style. Standard university texts, on the other hand, often assume a background that students do not possess, and usually progress at too fast a pace.

Some good books in this area are Rowntree (1981), Folks (1981), and Clegg (1981). The first of these contains good explanations of the ideas of statistics, but does not have enough exercises to be used as a textbook; the second is a textbook used for humanities statistics courses in America, and the third is used as a textbook for first statistics courses for students of psychology. Another book, with an Australian flavour,

written specifically for courses at this level, is Petocz (1990).

An alternative to a textbook is to use booklets written specifically for preparatory and bridging courses and focussing on specific topics. Such booklets are usually inexpensive to produce and can be quickly developed and revised as needed; they are particularly useful as individual study material. The Mathematics Learning Centre at the University of Sydney has a series of such booklets (for example, Gordon (1990)).

Books containing statistical essays and case-studies are an important resource in preparatory and bridging courses. Examples of these include Mosteller (1973), Tanur (1978), and Brook and Arnold (1986). Also needed are books which contain experiments, simulations, and practical projects. Many are described in Petocz (1990), and others can be found in four volumes by Landwehr et al. (1987), although these last books are aimed more at school children. Freedman, Pisani and Purves (1978), although working at a generally higher level, contains many useful exercises and thought-provoking "conversations" explaining important statistical concepts.

Students need a calculator with facilities for handling bivariate data: a good example is the CASIO fx-100c, but there are others available. They also need access to an easy-to-use statistics package on a computer. MINITAB seems to be a good choice; it is easy to learn, even for a beginner, yet is widely used in university courses. Other packages might be more appropriate, depending on what is used in first-year classes. For instance, the first statistics course at Macquarie University uses a locally developed package called SPIDA, and hence this may be the best choice for preparatory or bridging courses there. Various statistical programs are aimed specifically at developing statistical intuition and can be very useful in introductory courses. An outstanding example is Finzer and Resek (1986).

3. Future trends

In Sydney in the last five years, there has been a dramatic increase in the number of preparatory and bridging courses in statistics, or involving some statistics and probability. It is likely that such courses will continue to expand in the near future, and to remain educationally important for a long time to come.

Most Sydney universities have opened mathematics learning centres in the recent past, mainly to provide remedial tutorial assistance to first-year students, i.e. to those students who needed preparatory or bridging courses but did not get them. These centres are in a good position to see what courses are needed, and can play a focal role in setting up and running preparatory and bridging courses. A short video introducing mathematics learning centres and exploring students' attitudes to them has been prepared by Wood (1989) for the University of Sydney.

The subject of statistics plays a considerable role in their work, as in other areas of study. The latest change is a proposed joint finance and mathematics degree at the University of Technology, Sydney, which will contain substantial amounts of statistics. Any such changes to the structure of degrees increase the necessity for preparatory and bridging courses in statistics.

Changes are taking place to undergraduate courses, especially at the newer-established universities, to cater for the overall lower entry level caused by increasing the numbers of students. These include changes to the content or level of existing courses and the development of new courses. There is also a strong feeling among some

academics that the content and teaching methods of first-year undergraduate courses involving mathematics and statistics should be taught in a more gentle way and should include some component of study skills. Discussions are taking place at present at the University of Technology, Sydney, on ways of implementing this.

At present, there is some debate about the provision of preparatory and bridging courses for credit. Some universities are providing secondary-level mathematics courses for credit. Other universities, however, are unwilling to offer and credit secondary-level courses in a tertiary degree, arguing that this is not the function of tertiary education. Reasonable arguments have been presented on both sides of this debate. However, it seems to be a fact of life that more people are enrolling at universities without an adequate mathematical background for the courses they wish to attempt, and that these people must be supported in some way. Statistics may provide a good solution to this problem. Since it is not generally taught in high school, it can be offered for credit at tertiary level; at the same time, it can be used successfully to revise a substantial amount of basic mathematics and to introduce necessary computer skills in a new context. This may lead to an increase in the popularity of preparatory and bridging courses in statistics.

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