

**"MORE ABOUT LESS OR LESS ABOUT MORE?"
DEPTH VERSUS BREADTH IN THE STATISTICAL EDUCATION
OF BUSINESS AND ECONOMICS STUDENTS**

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1. Introduction

Designing a university course involves making decisions about syllabus content, structure and sequence, about teaching methods and about assessment of student learning. This paper is concerned with the first two of these three matters and, in particular, with their relation to the balance between depth and breadth of treatment of the subject matter. I take as my focus the teaching of statistics to business and economics students, though a lot of what I say will be relevant to university teaching of any subject in the technical or social sciences.

Much has already been written on university teaching of statistics to non-specialists in the subject. A number of themes recur in this literature: the optimal balance between theory and practice and between mathematical and nonmathematical exposition; the best way to use case studies/student projects/the computer in applied statistics courses; whether service courses are best taught by professional statisticians or by subject-matter specialists.

But the issue of depth versus breadth, in both syllabus design and style of presentation, has received no more than passing mention.

Why this important theme has been little explored is not the central question here. My purpose is, rather, to show that it is an important theme and to argue that breadth deserves more prominence than it traditionally receives.

2. Depth versus breadth in undergraduate statistics – the genesis of the dilemma

Until about 25 years ago relatively few university students studied statistics outside the specialist Department of Statistics, where an emphasis on both comprehensiveness and detail was regarded as imperative in preparing for a professional career in the discipline. In other areas, such as economics or psychology, students could be offered a thorough grounding for their needs in a statistics minor of two years, for there simply was not yet much in the way of statistical technique of established practical value in these fields.

Nowadays the situation is very different. In Departments of Business, Accountancy and Marketing there is a vast audience for the teaching of sta-

tistical methods and their applications in these areas. Moreover, relevant theoretical advances in data analysis, statistical computing, decision theory, multivariate analysis, time series analysis and econometrics mean that there can be no hope at all of presenting a broad and deep view of the subject in the usual undergraduate business or economics degree program. Selectivity has become essential, and so has the necessity to strike a thoughtful balance between depth and breadth of treatment.

This is often seen simplistically as a debate over "more about less or less about more" but there is more to it than merely a weighing up of quantities of knowledge. There are vital qualitative dimensions as well. This is how I see them.

By "depth" I mean close-focus theoretical (and, possibly, practical) exposition of techniques in some logical order but more or less in isolation from one another. Depending on the course level and audience preparedness there may or may not be attention to formal proofs and investigation of mathematically intractable cases. The emphasis is, in any case, mainly on tools rather than problems. Students learn intensively what each of a relatively small number of tools can achieve, rather than how to choose a tool for a real-life situation.

By "breadth" I mean an exposition with these four intrinsic characteristics: (a) wide range of topics, (b) frequent detachment from details to gain a perspective viewpoint, (c) emphasis on structured principles of statistical modelling, (d) problem-centred rather than technique-centred applications. A course with these characteristics will imbue students with an attitude of mind towards problem solving which I shall call "contextual statistical thinking". By this I mean the ability to see statistical real-world problems in their practical as well as their theoretical context and to devise solutions which fulfil the requirements of each.

The dilemma of depth versus breadth clearly concerns in a fundamental way the whole structure of the course as well as its presentation. That is what makes it so important.

In seeking to resolve the dilemma, one must view syllabus prescription and classroom presentation as separate elements. Certainly, the syllabus has the dominant influence. However, classroom presentation can alter the slant of the formal syllabus. It is, in particular, quite possible to inject considerable breadth of view into a syllabus couched in terms of depth. Ways of doing this include introducing illuminating anecdotes from the lecturer's professional experience, snippets from the history of statistics, and ad hoc excursions from the lecture topic prompted by questions from the class.

Before considering ways of resolving the issue, let us first look critically at some arguments that have been made for each approach.

3. Arguments for an accent on depth

The traditional argument for depth is that it is indispensable for a scholarly treatment and, hence, is the obvious approach in a university curriculum. In years past, when specialist study was its own reward, this view was perhaps supportable as an ideal.

Nowadays, for better or worse, tertiary study is mostly expected to serve functional ends, especially study in areas that are ancillary to the degree major. The need for a deep approach has lessened correspondingly. Yet, many university statistics courses for nonspecialists remain heavily committed to depth, both in syllabus and presentation.

Students whose course is slanted markedly towards depth of treatment are in danger of developing an undesirable compartmentalisation of knowledge. Indeed, it is a common complaint of such students that they can manage the textbook end-of-chapter problems easily but find themselves at a loss with more open-ended practical questions.

Another argument for depth, as I have defined it, claims that unless students have some "solid knowledge" of technique of an intensive kind they will not have a "marketable" degree. In our context, this view reveals a misapprehension about the nature of the business or economics degree. It is by nature a generalist degree and is so regarded by most employers. They look for adaptability, maturity of thought and the ability to synthesise diverse pieces of information into policies for effective action. None of these attributes is fostered by a limited and intensive study of technique.

It is also commonly said that, if students are to retain a residue of fundamental statistical knowledge in the years after they leave university, a heavy dose of the material must be administered to them during their studies. This is then construed as meaning that only a narrow and deep course can have a lasting educational impact.

The contrary is true! It is not the quantity of detail learned that governs the degree of retention, rather it is the degree of motivation that was evoked in the course of study and the degree of understanding that was consequently acquired. I contend that, though there is always some place for depth, maximal motivation for nonspecialists derives from a broad treatment of the subject and maximal understanding results from a mastery of contextual statistical thinking.

4. Arguments for an accent on breadth

A strong argument for breadth in the syllabus is the value of giving students a perspective over a substantial area of statistics so that its cohesion and unity are apparent. This can be assisted by showing that often the same analytical procedures are applicable in diverse areas of the subject. As a result, students will more readily appreciate "what statistics is all about", which should be an incentive to learning the theoretical details.

But a broad approach to syllabus design can go further. By tracing the path from real-world problem to abstract representation and back again from abstract solution to practical interpretation, a broad approach keeps the relevance of the course constantly in view. This interplay between abstraction and reality is (as econometricians know well) the epitome of statistical modelling. The elements of modelling (which I like to represent by the acronym SIEVE: specification, identification, estimation, validation, exploitation) thus have a natural place in a course with an accent on breadth.

When they have grasped the intent of the modelling approach and the role in it of each of the above elements, students will see clearly that statistical techniques can supply only part of the solution to quantitative real-world problems. They assist only in the pursuit of "statistical significance", whereas the solution to any practical problem, say, in economics, needs something more, namely contextual relevance, or "economic significance". That students readily appreciate the critical distinction between, and essential complementarity of, statistical significance and economic significance is a salient benefit of what I have called contextual statistical thinking.

Breadth has its limits, however. It is all too easy to raise more questions than can be answered. If answers to such questions are nonetheless offered, care must be taken not to over-simplify so drastically as to teach something actually false.

There is, moreover, little value in regaling students with a host of superficial impressions about the many things statistics can do for their eventual professional needs, with a concrete instance thrown in here and there. This is talking about statistics, rather than talking or doing statistics. It is a travesty of breadth.

5. Striking a balance

Notwithstanding the criticisms in the foregoing discussion, depth and breadth do both have a place in course structure and presentation. The dilemma remains: how much depth and how much breadth?

In principle, the appropriate balance ought to depend on (i) the objectives of the course, (ii) students' expectations (iii) the learning time available and, not least, (iv) the lecturer's judgment, based upon experience, wisdom and insight.

When we teach statistics to business and economics students we may generally take as given student expectations of the subject (utilitarian) and course duration (most commonly 1, 2 or 4 semesters). How we balance depth and breadth is then a matter of recognising the role of the course in the educational program of the degree, and of many finer judgments on what constitutes enlightening presentation in each individual case.

I want now to consider as paradigms three statistics courses and to propose an appropriate balance in each case.

(a) 1 semester undergraduate introduction for business and economics students

This is usually offered in the first year and may be the only undergraduate quantitative unit taken by business students that is taught by a statistical specialist. The temptation is therefore to tap the lecturer's technical skills by emphasising depth over breadth in the syllabus. This is appropriate, for it is important at the foundation stage that students acquire a firm grasp of basic principles. Moreover, opportunities to apply well-drilled basic statistical techniques will surface in higher level accounting, economics or marketing subjects and supplementation of formal technique and problem-solving procedure can take place there.

On the other hand, it is in the introductory course that the scope for breadth in presentation is often most sorely neglected. Whilst students are concentrating on the basics of statistical procedure (so frequently intellectually alien to them), there can be outstanding benefits in guiding them to preserve a perspective over the myriad details and to acquire the rudiments of contextual statistical thinking. In this way, both their interest and, one hopes, their awakened enthusiasm can be nurtured.

(b) 3-4 semester undergraduate minor sequence for economics students

The component courses of the sequence, usually beginning with the semester-unit described above, form a foundation in statistics and elementary econometrics for economics majors. In a program of this length there is scope for a treatment in which breadth can be more or less equally balanced with depth. Accordingly, opportunity should be taken to explain the aims and structure of the modelling approach, to draw attention to the limitations of the techniques studied, and to appraise their worth in practice.

The utility of the course need not be constrained by the quantity of formal theory that is included. By prescribing carefully selected papers from the professional literature for outside reading and by designing appropriate computer simulation materials, an informative glimpse of professional quantitative work in theory evaluation, forecasting and policy design can be provided.

(c) 2 semester graduate (e.g. M.B.A.) introduction for managers

Because it is aimed at displaying the gamut of quantitative techniques for managers, and because some prior acquaintance with formal statistical theory can ordinarily be assumed, this kind of course should lean strongly towards breadth.

Exposition of principles in such courses is customarily complemented by practical challenges formulated as case studies. The case study is, of course, justly celebrated as a problem-centred (and, hence, broadly based) method of teaching practical skills.

7. Recommended - a greater role for breadth

This review of the issue of depth versus breadth leads me to two conclusions: statistics courses for business and economics students need to contain regular overviews and unifying insights; they should also convey an understanding of contextual statistical thinking, as I have defined it. The educational value of these aspects of breadth seem to me to be insufficiently recognised either in the classroom or in the statistics teaching literature.

Why is this? Two possibilities come to mind.

Firstly, because statistics textbooks are rarely written this way. And secondly, because academic tradition simply does not appreciate the contribution breadth can make in the short term to students' enthusiasm for the subject and to their perception of its usefulness, and in the long term to establishing patterns of thinking.

Details of technique may fade from memory. But the pattern of contextual statistical thinking, once absorbed, will continue to illuminate statistical problems the student may encounter in future years. There is truth in the adage "education is what remains after what has been learned has been forgotten".