

STATISTICS TEACHING AND THE TEXTBOOK — AN UNEASY ALLIANCE

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What is the textbook actually for? Does it meet the individual needs of learners in the course? How well does it contribute to students' achievement of learning goals? University teachers of standard courses on the principles of statistics seem seldom to inquire at all deeply into these matters. Unless they do so, they may unwittingly erect discouraging obstacles for some learners – the unquestioning teacher and the textbook have an uneasy alliance! This paper identifies such obstacles to learning and traces some of the issues examined back to inherent limitations of the printed textbook as a pedagogical tool. Might an electronic text better satisfy individual learning needs? Has the printed textbook, in fact, a future? The paper concludes with comments on these significant issues.

INTRODUCTION

The recent papers by Garfield (1995) and Moore (1997) provide an overview of pivotal factors in modern statistical education. Neither of these papers attaches any special significance to the textbook. Yet, a textbook is (almost) always there – prescribed by the teacher for purchase by every student. Is there really so little that is weighty in the role of something that has always been part of the study of statistics? This paper considers the situation. Its focus is on the conventional principles textbook that is generally used in introductory statistics courses with large enrolments, where two new and stimulating kinds of textbooks that promote learning-by-discovery (e.g. Rossman (1996)) or practical problem-solving (e.g. Chatfield (1995)) might be ineffective.

The three questions that lead the Abstract, above, need to be considered at the time the textbook is chosen and again during the course. Unless teachers do so, they may unwittingly erect discouraging obstacles for some learners. The next section puts these matters in perspective, dwelling on some points that are worth the teacher's consideration.

THREE FUNDAMENTAL QUESTIONS

What is the textbook actually for?

Most teachers aim to use a conventional principles-focused textbook in three ways:

- (a) as a parallel exposition of the subject matter they are teaching in class;
- (b) as a source of knowledge of statistics beyond the course syllabus; and
- (c) as a source of examples and exercises on statistical theory and application.

- (a) What is the teacher's exposition in class to be? Is it to replicate the textbook, to be complementary to it, or to be an alternative to it? (Note: students are not always informed of the teacher's intention in advance.) If it is to replicate, then the teacher is "lecturing the textbook". (Note: with able students, this is a guarantee of student boredom.) If it is to be complementary, it implies that the teacher will focus only on certain facets of each topic, leaving the students to get the complete picture from the textbook. (Note: if the textbook is unappealing, students will get no coherent picture at all.) If it is to be alternative, then students are invited to mentally merge two close but distinct expositions to derive a richer understanding. (Note: If the alternatives are too dissimilar there may be only bewilderment, and not a richer understanding!)
- (b) A textbook can be read right through just like any other book, but without the teacher's encouragement students may not contemplate doing this. The outcome will depend a lot on how inviting and motivating *the student* finds the text is to read.
- (c) A textbook's examples and exercises are its main way of linking statistical theory to practical reality. Cobb (1987) analyses excellently the educationally demotivating effects of poorly conceived exercises, but does not touch upon the problem of cultural bias in such exercises. An author's reality is, in general, strongly rooted in his/her own socio-cultural environment and this may be very different from and very alien to the student's.

Does the text meet the individual needs of learners?

Why is this a fundamental question? Garfield's (1995, p. 30) answer is to the point and has profound implications: "Regardless of how clearly a teacher or book tells them some-thing, students will only understand the material *after they have constructed their own meaning* for what they are learning" [my italics]. Among other things, it suggests that the more closely the knowledge a textbook assumes matches what a particular student actually knows, and the more closely its expository style matches the way that student thinks, the more speedily that student is likely to form a firm understanding of the subject matter.

Whether this matching will actually happen is bound up with the way the textbook is chosen. Whoever chooses the textbook, it seems to be unusual to have student input on the decision. This is quite paradoxical, seeing that it is students who are the text's principal users! It is not difficult to devise a mechanism for including informed student

opinion in the process of textbook selection. Following Garfield, quoted above, there is wisdom in selecting not just a textbook, but several more books as well, with a variety of pedagogical approaches and expository styles, to function as “reference books” alternative to the text. Student input can contribute something else valuable to the choice of these books: views from non-native speakers of the language of instruction. Such students form a fair proportion of the statistics classes today in many English-speaking universities.

Are such consultations with learners worthwhile? Schacht’s (1990, p.395) tart assessment implies the answer is clear: “... texts neglect many important student instructional needs. Apparently publishers are concerned more with meeting the needs of instructors ... because instructors, not students, choose which texts are adopted.”

How well does the text contribute to students’ achievement of learning goals?

It is useful to distinguish two kinds of learning goals (whether proposed by the course designer, or set by the learner for him/herself): (a) short-term goals; (b) longer-term goals. Familiar goals of type (a) are: *gaining a high grade; acquiring a coherent understanding of the subject, and being able to apply that understanding to solving real-world problems*. Examples of type (b) are: *retaining learning for the long term, and learning how to learn*.

How well does the text contribute to achieving such goals? This question is related to the one in the previous subsection. Goals of type (a) are better achieved when the student is studying an exposition that closely matches his/her own preferred learning style. A goal of type (b) requires something more in a text, namely, that the author has set the same goal in writing it as the learner has set for studying it. For example, it is not likely that one can *learn how to learn* statistics using a text which has only heuristic explanations. Statistical inference has a fundamentally formal structure. Seeking a firm understanding of this structure without a teacher after learning the foundations heuristically is like trying to teach oneself heart-lung physiology on the strength of holding a first-aid certificate.

THE UNQUESTIONING TEACHER AND THE TEXTBOOK – AN UNEASY

ALLIANCE

Whatever the ideal, the three questions just examined tend, in practice, to get little detailed consideration. The teacher commonly chooses the textbook without deliberative student input and then issues a detailed list of textbook sections to be studied and textbook exercises to be completed. On the basis that any choice is to an extent a compromise, the teacher simply presumes the textbook he/she has chosen will suit all students, more or less.

But *to what extent* is the chosen text a compromise? How much does the teacher *actually know* about what use each student makes of the text and about how well each student learns from it? My survey evidence [see Acknowledgments] indicates that *the teacher's direct knowledge on both these issues is generally slight*. Some *indirect* information may accrue from end-of-semester course evaluations, but this information tends not to be very constructive since students usually write only briefly, if at all – perhaps, in some cases, because they have hardly used the text (see section 4).

It is incongruous – we may conclude – to devote care to linking the text closely with class teaching when one is largely uninformed about (i) the extent to which individual students find the text helpful, and (ii) the learning problems of those students for whom the text is not helpful. Therefore teachers who do so have cause to feel uneasy about the worth of their effort.

SOME INHERENT LIMITATIONS OF THE PRINTED TEXTBOOK AS A PEDAGOGICAL TOOL

Even if there is student input on the choice of text and reference books (but also if there is not), some students may prefer learning actively in class to learning passively from one of these books. Their reasons will probably relate, in part, to some inherent limitations of the book. A book is *non-interactive* – the author addresses the reader but there is no converse possibility. It is *content inert* – its content cannot change before there is a new edition, or, at least, a reprinting. It is *static* – its pages are fixed in order, its graphics still. Its *unit cost of production is high* relative to that of most electronic publications; and it is *physically bulky* – all of it must be handled even if only a part of it is of interest.

The first three of these characteristics explain why it has always been hopelessly inconvenient to personalise a textbook for the needs of different learners. But now, using new technologies, there are some alternative possibilities.

THE TEXTBOOK TRANSFORMED – SOME NEW PEDAGOGICAL TOOLS

THE COMPANIONATE-AUTHOR TEXTBOOK is a textbook plus a dedicated Website. A good statistical example of a companion Website is Rossman's (1996) [see References]. The Website's function is to compensate for the first two of the limitations of a book, namely, its non-interactive nature and its content inertia. Readers can notify the author via email of typographical and other errors (such as those noted by Brewer (1985)), and express their views generally on the text. The Web page serves to disseminate corrections, improvements, and additional material, long before a new edition, or even a new printing, is due.

THE MULTIMEDIA CD-ROM TEXT's merit is in overcoming the last three of the inherent limitations of the book mentioned above. Though there does not yet seem to be a statistics text of this type, some CD-Roms to complement a textbook have appeared (Cobb (1997)).

THE EVOLVING ON-LINE TEXT is such a recent innovation that none is yet as comprehensive as its designer plans it to be. The term *evolving* highlights the fact that such a publication can never strictly be finished, for it is expected to change continually in response to its readers' needs. In this sense, the evolving on-line text is a cybernetic synthesis of printed textbook and companion Website. In addition it can offer dynamic interactive displays, hyperlink branching, and the potential to provide readers with customised expositions, institutional information, and examples (e.g. for readers in different societies and cultures).

In sum, the evolving on-line text has almost none of the intrinsic constraints of the printed book. But it has some drawbacks of its own, not the least of which are that it is expensive to maintain on-line, and that it may be expensive to read, especially given the cost-inflating effect of the "World Wide Wait"! The choice in on-line statistics texts is still limited. Some five substantial projects are currently in progress: Dear (1995+), Lane (1995+), de Leeuw (1996+), Stockburger (1996+), and Bryc and Pelikan (1997+). These all differ in their structure, flexibility and pedagogical quality. de Leeuw (1997) describes the complexities of this kind of project, remarking ruefully on "the desperate race to keep up with rapidly changing technology". Can an on-line text satisfy individual learning needs? The answer at present is "a definite maybe"! The potential is there, but its realisation still lies ahead.

CONCLUSION

Electronic publications, with all their promise, are still only complements to, and not yet viable competitors of, the best printed statistics textbooks. To judge from the surge of new printed titles in statistics, publishers believe that this situation will not change for some time. To judge from the proportion of look-alikes among these new titles, publishers believe in “doing it better by doing it more”.

However, what is needed for effective statistics education is not a surfeit of look-alike textbooks, but rather a real range of choice in content and style. This paper has argued that teachers should ask some fundamental questions about their textbooks, in particular whether these texts satisfy their students’ individual learning needs. In choosing books to best achieve that goal, the thoughtful input of students is vital. This input has not always been sought. In such cases, teachers might think of “doing it better by doing it differently.

ACKNOWLEDGMENTS

In connection with this paper I have been conducting an interview survey of Australian academics who taught an introductory statistics course to students of business or economics in 1997. An extended version of this paper, with salient findings from my survey, will be available from me in June 1998. In the interim I want to express particular appreciation to these interviewees: Chris Brien, Averil Cook, John Crawford, Kerry Cullis, Kevin Donegan, Howard Doran, John Goodhew, Brett Inder, Ian James, Nazim Khan, Guay Lim, Ian McDermid, Don Poskitt, Antony Selvanathan, Ross Shepherd.

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