Metodološki zvezki, Vol. 4, No. 2, 2007, 219-229

Improving Student In-Depth Understanding of Statistics: The Case for Offering Historical Insights in Statistics Courses

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Abstract

When striving to improve student in-depth understanding of statistics, one of the most important challenges instructors face is overcoming the negative student attitude towards statistics. This paper focuses on one approach that has been very effective, namely the inclusion of historical insights into statistics courses. Possibilities of doing that are numerous and range from simple exercises (e.g. assigning a face to the name, or discussing examples of famous past statistical achievements and blunders) to well-rounded lectures (e.g. on socio-economic context of past developments in statistics and methodology, or the role of women in statistics). In the paper, the advantages and disadvantages of this approach are discussed in detail along with several excellent resources that can aid instructors in their endeavours to give statistics a more human face in the eyes of their students.

1 Introduction

The negative attitude of students towards statistics is often reported (Gordon, 1995; Sowey, 1998; Francis, 2002; Martin, 2003; Ograjenšek and Bavdaž Kveder, 2003). We have repeatedly experienced it in case of the courses on economic statistics and business statistics taught at the University of Ljubljana's Faculty of Economics to undergraduate students in the second year.

The course on economic statistics was introduced into the undergraduate university study programme on economics in the fifties of the previous century. The course on business statistics became part of the study programme at the undergraduate college of business about two decades later. Both courses are part of the compulsory pre-Bologna-reform curriculum, following the 1st year course on introductory statistics.

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Topics covered in the courses (at a different level of detail and abstraction for university and college students) include statistical units, classifications and registers, selected chapters of demographic statistics, introduction to the theory of index numbers (with emphasis on price, production, wage and productivity indices) as well as introduction to national accounting. One of the principal goals of both courses is to give students enough background knowledge to become informed users of official statistics, capable of carrying out their own research projects based on (or enhanced by) the use of official statistical resources.

The teaching process takes place in form of lectures, group tutorials, and a computer lab seminar. Many of the approximately 80 full-time students of economic statistics and 500 full-time students of business statistics already got acquainted with statistics in high school, others in the first year of their undergraduate studies. The nature of their past experiences probably influences their interest in statistics as well as their attitude towards economic and business statistics. The instructor's job is therefore not an easy one: to overcome a negative student attitude towards statistics. In other words, the instructor needs to gain (and retain!) students' interest in statistics.

But how should one go about overcoming the negative student attitude towards statistics?

2 Practical attempts to overcome the negative student attitude towards statistics

Generally, practical attempts to overcome the negative student attitude towards statistics can be crudely classified into the "honest" and "less honest" ones. "Honest" attempts include:

Development of handbooks for instructors. One to recommend is Gelman and Nolan's *Teaching Statistics – A Bag of Tricks* (2003).

Preparation of reference books for instructors and students. Examples include Salkind's well written and nicely illustrated *Statistics for People Who (Think They) Hate Statistics* (2004) and Field's tome entitled *Discovering Statistics Using SPSS* (2005).

Incorporation of modern IT tools in lectures and tutorials. These come in various forms ranging from analytical and simulation software packages to webpages with directories of useful resources (such as *The World Wide Web Virtual Library: Statistics* or *The University of Michigan's Statistical Resources on the Web*), complete stand-alone on-line courses (e.g. the

Course on European Economic Statistics[2]) or even complex web-based learning platforms for a multitude of statistics courses.

Making teaching memorable. Sowey (1995) differentiates between attributes which make the **instructor** memorable (ability to establish rapport with students and give clear explanations on one, personal qualities of the instructor on the other hand) and those that make the **subject** memorable (coherence in exposition, perspective in presentation, intellectual excitement, resilience to challenging questioning, and demonstrated practical usefulness).

The "less honest" attempts include endeavours to change the names of statistics courses into something which should be perceived as "easier", "more acceptable" and "more fun" by students, e.g. *Business Decision and Information Analysis* or *Evidence-Based Management.*

At the 2004 conference of the *European Network for Business and Industrial Statistics*[3] in Copenhagen, one of the speakers[4] seriously argued in favour of the necessity to change the existing statistical terminology in order to make it less complicated and easier to grasp for students of business. While it is not difficult to empathise with him (teaching statistics to students of business can at times indeed be **very** frustrating), it needs to be pointed out that hypothesis testing or analysis of variance would certainly not gain in appeal if called any other way. In words of immortal Shakespeare[5]:

" … What's in a name? that which we call a rose
By any other name would smell as sweet; … "

Instead of putting up unnecessary smokescreens, thereby adding to an already overwhelmingly huge terminological barrier between business and science graduates, instructors should focus on constantly improving ways of gaining and retaining students' interest in statistics.

At the first glance this might seem to be very difficult. However, both gaining and retaining students' interest in statistics can actually be achieved with relatively little effort, by adhering to three golden rules:

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[2] The stand-alone on-line *Course on European Economic Statistics* was developed at the University of Ljubljana's Faculty of Economics in 1999 (Bregar et al., 2000) and is currently up for major re-evaluation and harmonisation with the latest developments in the field of official statistics.

[3] For details on the *European Network for Business and Industrial Statistics (ENBIS)* visit www.enbis.org.

[4] Christopher McCollin in the presentation entitled *Some Aspects of Teaching Quality to Business Students*.

[5] Quote from Shakespeare's *Romeo and Juliet* – Scene II: Capulet's orchard. [URL: http://www-tech.mit.edu/Shakespeare/romeo_juliet/romeo_juliet.2.2.html].

Rule number one, regardless of the students' chosen field of expertise (yet too often forgotten by statistics instructors), is the following: each session should be structured as a theatrical performance. Sessions without a logical flow (an introduction, a peak, a conclusion), clearly presented goals, and well summarised key message(s) will produce frustrated students and, ultimately, frustrated instructors.

Rule number two is even simpler: whenever possible, sample calculations should be conducted using datasets of immediate interest to students – soccer game outcomes should be predicted, trends in *Formula 1* drivers' earnings should be calculated, the efficiency of medical treatment in the *Emergency Room* and *Chicago Hope*[6] should be compared, and so on.

Rule number three is about giving statistics a more human face by conveying the feeling of its 'worthwhileness' which Sowey (1995) identifies as "a key motivator of students to learn well in class", as well as "the key to effective self-directed learning in the future".

In Sowey's (1998) opinion, traditional statistics teaching focuses too closely on the subject matter and hardly leaves any pauses for perspective, or much escape from heavy abstraction: "…the [course] material does not appear to have any of its origins in any specific times or places. Names may be mentioned (Bernoulli … Bayes … Student … Poisson …), but these are all fleeting allusions. One has little idea whether the material is historically young or old, or whether anything that needs to be worked out on a particular topic has already been worked out somewhere."

Such teaching usually results in what Sowey (1998) calls the "motivational vacuum". It poses a serious threat to the course reputation. In order to rescue the situation, thoughfoul and resourceful instructors should offer their students the following perspectives:

Perspectives on purpose: to know why one is learning. Meaning should be given both to the course (especially if it is a service course!) and the discipline.

Perspectives on structure: to know 'how it all hangs together'. Deep understanding of the subject matter and, consequently, a long-term retention, can only be facilitated by the clear course structure.

Perspectives on structure can be further classified into perspectives on the continuity of themes, perspectives on the unity of patterns, and perspectives on the

[6] An assignment on the application of the contingency table and chi-square test statistics featuring *Emergency Room (ER)* and *Chicago Hope* can be found in Albright et al. (1999).

integration of knowledge[7]. Of these, the first group is of special interest in the framework of this paper.

Perspectives on the continuity of themes can be either **longitudinal** (ensuring that students have an overview of the discipline as a whole and know where they are at the moment) or **lateral** (enriching student understanding of individual topics by putting them in a broader interdisciplinary context). Sowey (1998) identifies three different lateral perspectives particularly valuable in teaching:

> The purpose of **intuitional perspectives** is to give students an immediate feeling of 'command' over the subject matter. As a result, many of them will find the abstractness of formal topic presentation less intellectually intimidating.
>
> The purpose of **methodological perspectives** is to subject suitability of presented statistical tools for the declared analytical purposes to questioning.
>
> And, last but not least, the purpose of **historical perspectives** is to give students "a sense of time, place and personalities". By natural yet purposeful and (where necessary) low-key inclusion of historical insights in the course, positive statistics associations can be built up.

As a consequence of offering students all these perspectives, statistical knowledge can become well-rounded and 'whole'.

Lateral perspectives in form of historical insights can be included in any statistics course – be it of a general or specialist focus. The examples in this paper which are discussed in the following section are presented in the framework of two undergraduate service courses taught at the University of Ljubljana's Faculty of Economics. Both (the course on economic statistics and the course on business statistics) were briefly described in the introduction.

3 Examples of historical insights

When attempting to classify the applicable historical insights we decided against the use of more sophisticated approaches, relying on the contents and the required in-class time as the only classification criteria.

In the following presentation, shorter historical insights are followed by the longer (and consequently more complex) ones. From the viewpoint of contents, they are classified into four groups:

[7] For details see Sowey (1998).

Assign a face to a name. Discuss biographies of famous statisticians, preferably in form of short anecdotes, many of which can be found in Salsburg's masterpiece from 2001 with the title *The Lady Tasting Tea – How Statistics Revolutionised Science in the Twentieth Century*. A systematic overview of celebrated statisticians and their work across centuries is given in Heyde and Seneta's *Statisticians of the Centuries* (2001). More advanced learners might be interested in David and Edward's *Annotated Readings in the History of Statistics* (2001). Useful information can also be obtained on-line from *The History of Statistics* webpage[8].

In the framework of the courses on economic and business statistics, the anecdotes are usually used during the introductory lecture which starts with the group brainstorming on the topic of "what is statistics". Inevitably, students come up with a selection of statistical indicators they already know from the introductory statistics course (for example the Pearson correlation coefficient), or tools of graphical analysis (such as the Gauss curve).

In the later lectures, topics such as the theory of index numbers might be accompanied by a short discussion of what made Laspeyres think about his formula to calculate the price increase in 1871 and why, to this date, it is so important to measure and predict inflation. The concept of purchasing power can be illustrated with the help of many inflation calculators available on-line[9].

When discussing economic aggregates and economic growth, it it unavoidable to stop and mention the contributions of John Maynard Keynes, Colin Clark, and Simon Kuznets. However, with students of economics, the instructor is well advised to limit the discussion to issues at hand, otherwise it might end in an open conflict between advocates of the interventionist Keynesian economic policy on one, and the followers of the neoclassical liberal doctrine on the other hand. But even if that happens, the instructor can bring the discussion back home by pointing out the effects of the ageing population on public welfare schemes, and continue with selected chapters from demographic statistics.

[8] See http://www.Anselm.edu/homepage/jpitocch/biostatshist.html for details.

[9] Several institutional data providers nowadays offer the so-called inflation calculators on-line. Examples include the *US Bureau of Labour Statistics* [URL: http://www.bls.gov/bls/inflation.htm], *Statistics Canada* [URL: http://www.bank-banque-canada.ca/en/rates/inflation_calc.html], and the *Statistical Office of the Republic of Slovenia* [URL: http://www.stat.si/eng/orodja_osebnainflacija.asp].

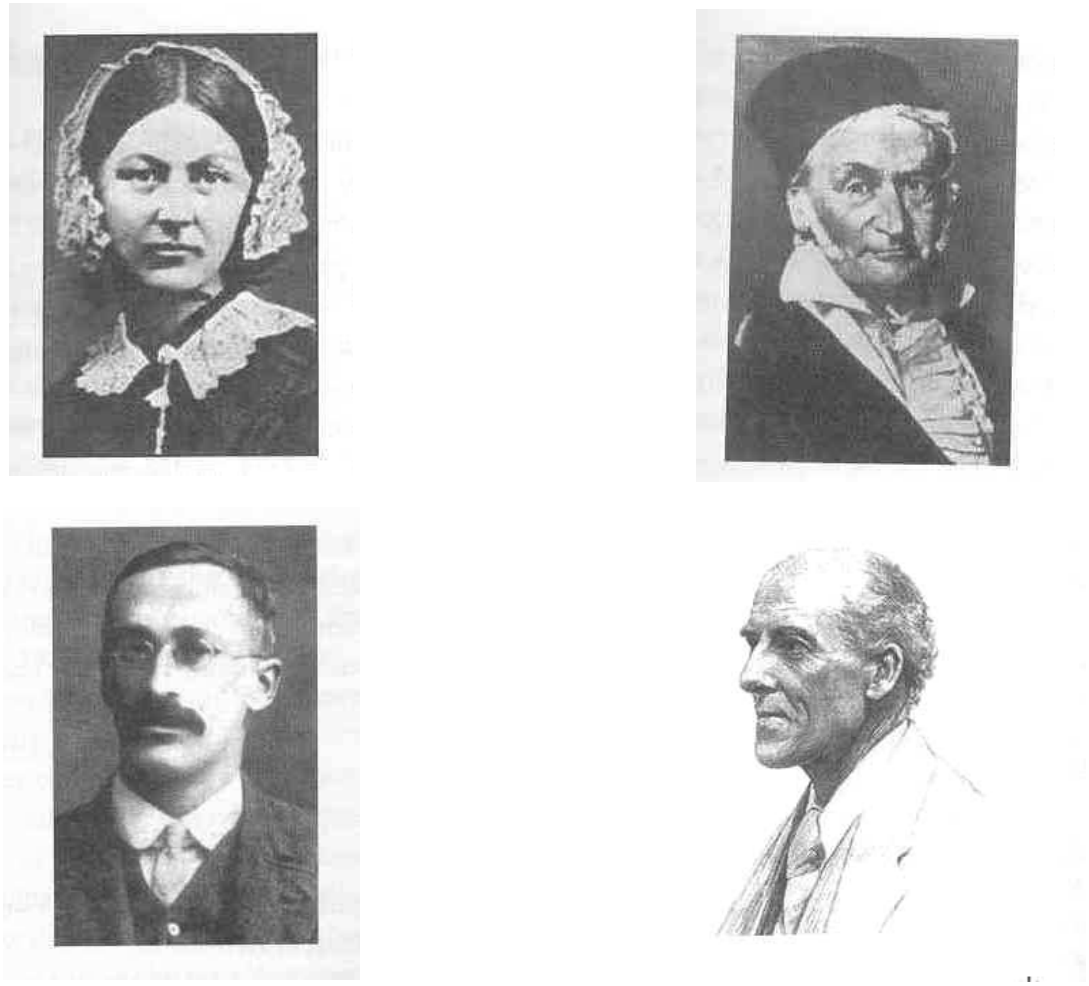

Figure 1: Who among these four famous statisticians is neither Gauss, Gosset, nor Pearson? (Source of photos: C.C. Heyde and E. Seneta: Statisticians of the Centuries. New York, Springer, 2001.)

- **Discuss famous statistical blunders.** Many are described and wittily illustrated in Huff's classic *How to Lie with Statistics* (originally published in 1954 and still of great interest). Hooke's *How to Tell the Liars from the Statisticians* basically covers the same material, although slightly less efficiently. For speakers of German, Krämer produced a similar text in 1997 (*So lügt man mit Statistik*).

  Presentation of blunders and their subsequent consequences (e.g. changes in public opinion or public spending, negative effects on corporate image, etc.) should be included in the lecture on ethics in empirical research. In the framework of our course on economic statistics we give one before students start working on their seminar papers.

Within this lecture, special emphasis is also given the context of data interpretation. An illustrative example from the internet (source unknown) serves the purpose well:

> *In the 18th century, when virtually all bread was baked at home, the average life expectancy was less than 50 years; infant mortality rates were unacceptably high; many women died in childbirth; and diseases such as typhoid, yellow fever and influenza ravaged the whole nations.*

Apart from the discussion of possible (logical and illogical) conclusions following from this statement, the example might also serve as an introduction into the topic of development indicators.

- **Present developments up-to-date in …** data collection techniques, data analysis, data visualisation, quality management, etc. For example, William I, the Conqueror (who was the ruler of England from 1066 to 1087) commissioned the *Domesday Book*[10] in 1085 as a survey of land ownership to assess property and establish a tax base. By asking which ruler commissioned the first survey on Slovenian soil, approximately when and why, it is possible to use students' common knowledge of historical events under the rule of the enlightened empress Maria Theresia of Habsburg as an introduction into the discussion of modern censuses and their characteristics.

- **Discuss the socio-economic context of important statistical findings.** In this framework it is possible to explain close historical ties between agriculture and statistics (especially with regard to design of experiments – a topic at the core of modern corporate continuous quality improvement efforts), discuss the role of women in statistics (starting with the original meaning of the word "computer"[11]), inform students about the use of demographic and socio-economic statistics for military and tax purposes, etc.

Besides giving students a sense of time, place and personalities, thus achieving Sowey's 'wholesomeness' of statistical knowledge, additional added value of

[10] For more details visit *The Domesday Book Online* [URL: http://www.domesdaybook.co.uk/book.html].

[11] In the Preface to Karl Pearson's book *Tables of the Incomplete Γ-Function*, which was first published in 1922, we see that the word "computer" used to refer to a person, not a machine: on page xiv we read: "…supposing the use of a machine, which every modern computer has at his command … ". In most cases, the computers were female.

historical insights comes from application of knowledge in present. This is easily done by involving students in competitions and projects such as the search for statistical blunder of the month in press; assessment of the use of statistics in companies' annual reports and government reports; and so on.

4 Discussion and conclusions

Unobtrusive inclusion of historical insights into curriculum (no matter how crowded) has in our experience proved to be much appreciated by students, resulting in their more positive attitude towards statistics in general as well as towards the particular course. Although no formal attitude survey has been carried out yet, discussions with students, their comments ("I never thought statistics could be so much fun") and, ultimately, results of course evaluation, show that this is a path worth pursuing.

Those who feel that talking about famous statistical blunders might diminish the value of statistics as a scientific discipline in the eyes of their students should be reminded of the fact that each blunder represents a perfect learning opportunity.

However, it should be noted that while historical insights can make a strong contribution to awakening or stimulating student interest in statistics, their introduction (and introduction of any other kind of the so-called lateral perspectives) should be finely judged and timed (Sowey, 1998). They should be introduced at a natural point, and sustained only as long as they hold student attention. If not, their effect may become the reverse of what was originally intended: students may find them distracting, intrusive, or even irritating.

The challenge thus lies in including historical insights to enrich the course, yet not taking up too much of the precious course time and/or intruding on the coherent flow of any given topic or the course as a whole.

A further challenge of using the historical insights in class is the fact that bits and pieces of information as well as pictorial records usually need to be gathered from a multitude of sources. Often the search alone can be very time-consuming, not to mention the preparation of teaching notes, slides, and handouts.

However, this technical disadvantage is usually more than offset by lively discussions immediately following a historical insight, as well as increased student interest in practical applications of the statistical toolbox.

Acknowledgement

Earlier versions of this paper were presented at the 55th Session of the International Statistical Institute in Sydney (Australia) in the framework of the Invited Paper Meeting 52 on *Using History to Enhance the Teaching of Statistics,*

co-organised by the International Association for Statistical Education (IASE) and the ISI Christiaan Huygens Committee on the History of Statistics; and at the 2006 conference on Applied Statistics in Ribno (Slovenia). The author is very grateful for the comments and suggestions received by anonymous referees and session participants.

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