ON A NEW APPROACH TO AN INTRODUCTORY COURSE IN STATISTICS FOR BUSINESS AND ECONOMICS INCLUDING SOME EXPERIENCES

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1. Introduction

The signals from ICOTS-I confirmed and strengthened my impression, that the teaching of statistics for students in business and economics is generally unsuccessful. The result is, that only a few students – who often get a job at a business school – acquire a fair understanding of the application of statistical methods in business. For that reason we intensified the alteration of our course in statistics, so that we now run a course almost without any points of resemblance with the course we ran in the seventies. This paper deals with the contents of this renewed course including the preliminary experiences. Firstly, I will give a short description of the course and summarize our criticism of the former approach.

2. The Course

You often see papers and speeches on teaching statistics, which lack a description of the course and of the background of the students, thus giving rise to misunderstanding. To prevent this, here is a short description of our course:

The course is compulsory for students taking a general Bachelors Degree in business/economics – a degree which is prescribed to last 6 semesters (= 3 years). The background of the students is high school.

The statistics course is run during the first 4 semesters, and it consists of 53 double lectures and 22 double exercises:

Semester	Lectures	Exercises
1	11	4
2	11	4
3	23	9
4	8	5
	53	22

In the final part of the fourth semester the students work out a 6-week case study.

3. The Criticism

Formerly we ran our course like most do: We used one of the mainstream textbooks in "Applied Statistics for Business and Economics" and after 4 semesters of lectures and exercises the students were evaluated by a 4-hour written examination followed by an oral examination.

The result was disastrous: Most students were not able to see the use of statistics, so they totally lost the motivation to devote their time to the subject. Therefore they were not able to understand the statistical techniques presented in the course, and in the examination period many students were even not able to memorize the techniques, so they failed the examination. Statistics became then the best-hated subject in their study.
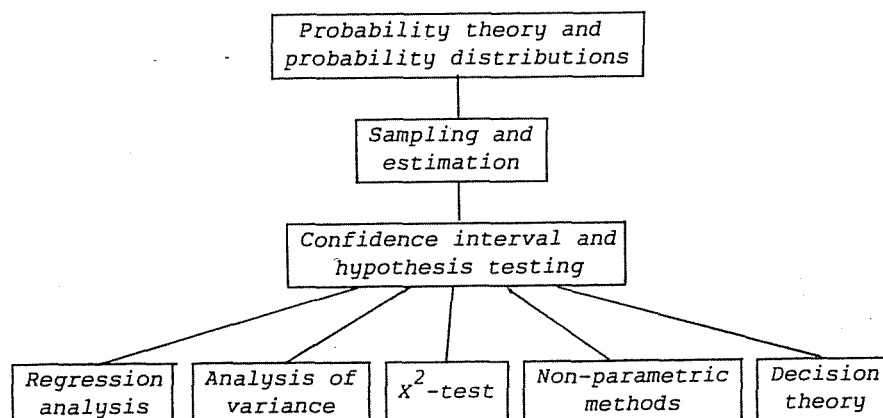
These students are now employed in business, and they still don't believe in statistics. This was proved in a research on 1978-school leavers. In a sample from 1984 these school leavers were − among other things − asked these two questions:

- To what extent are the subjects in your business study being useful in your job?

- For each of the subjects in your business study, indicate - on the basis of your job experiences − whether the subject should have a higher, a lower or the same priority?

Statistics is clearly placed at the bottom − see the tables in appendix A. (59% see no or little use of statistics and 32% think that statistics should have a lower priority, i.e. fewer lectures and less syllabus).

Others have reported on the same problems, and I think the criticism can be combined in 4 points:

a. The textbook. The main-stream textbooks are built up from a statistician's point of view, beginning with probability theory passing through sampling and estimation to the concepts of confidence interval and hypothesis testing; afterwards a collection of standard prescriptions are described.

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        ┌─────────────────────────────┐
        │ Probability theory and      │
        │ probability distributions   │
        └──────────────┬──────────────┘
                ┌───────┴───────┐
                │ Sampling and  │
                │  estimation   │
                └───────┬───────┘
          ┌─────────────┴──────────────┐
          │ Confidence interval and    │
          │  hypothesis testing        │
          └────────────────────────────┘
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| Regression analysis | Analysis of variance | x^2-test | Non-parametric methods | Decision theory |

    b. <u>Examples and exercises</u> act only as illustrations of specific statistical techniques and not as solutions of problems in business and economics by means of statistical methods.

    c. <u>The examination system</u> is either a short written examination where the question paper consists of small problems or an oral examination (or the both, thus emphasizing that the students have to learn specific techniques.

    d. <u>Computers</u> are neither utilized enough nor in the right way.

4. The New Approach

We have now altered our course in statistics on the 4 mentioned points. This has been done in more stages and we still haven't finished the alterations — in fact it's a continuous process.

I will here give a chronological description of the changes, thus giving the best background to understand the acquired experiences.

I. <u>Development of software for multivariate analysis</u> on a mainframe computer (1980-85). The software consists of exactly the sections of regression analysis, analysis of variance and log-linear modelling, that form part of the syllabus.

II. <u>Replacing the written examination by a 6-week case study work</u> (1983). These case studies can be characterized in the following way:

    a. The case studies bear on "real" problems involving "real" data.

    b. These real problems are within the business/economics field and the case study should preferably result in solving the problem.

    c. A fairly large dataset is involved in most case studies. Variables and/or samples are then to be chosen from the dataset.

    d. In a case study the students are passed through some of the stages of a statistical investigation:
      - Clarifying the need for data on the basis of the purpose of the investigation.
      - Sampling or delimiting the data.
      - Determining a priori hypothesis on the basis of theory and common sense.
      - Working out the statistical computations.
      - Making the conclusions, both concerning the problem in question and concerning the use of the applied statistical methods.

All the teachers — full-timers and part-timers — take an active part in the formulation and the implementation of the case studies. There are prepared around 10 case studies per year and each case study is solved by around 30-40 students; some cooperation — in groups of 2-4 — is allowed, but the final report must be individual. Around 10% of the students are called in as

a control. The case study is marked, and the mark is included on the degree certificate.

The following examples should give an impression of the broadness of the case studies:

a. The trade of convenience goods in a small town.
Take a sample from the census.
Evaluate the questionnaire.
Investigate the attitude towards establishment of a discount store.
Investigate the motives for the choice of supermarket.

b. Determining provisional rents for summer houses.
Evaluate the sample design and the collected informations.
Make a model of the rent for a week in the peak and the low season.
Estimate provisional rents for 4 specific houses.

c. Exchange movement DM/Danish kroner since 1979.
Data collection.
A model of the period 1979-1985.
A forecast of the period 1986-1988.

d. Auditing an inventory.
Selection of sample designs.
Sampling and estimation.
Decision on the further auditing and an evaluation of the sample designs.

III. Preparation of new textbooks (1981, 1984-), which radically break with the approach of the main-stream textbooks. The fundamental idea is to define a few main fields,which at the same time are essential to a bachelor of business/economics and include a large content of statistics. We have defined the following fields.:

a. Survey sampling
b. Quality control
c. Econometrics
d. Experimental design
e. Analysis of multivariate samples

We have prepared a textbook for each of these fields, yet is only the book on survey sampling in its final edition. Each book is opened with a general description of the field and its application to business/economics, including a discussion of the practical problems that one might meet. The rest of each book presents elementary analysis within the field, only including statistical techniques when needed.

Probability theory is regarded as an auxiliary subject, so it is only included when needed in the different fields of application. Still 2-3 lectures on the concepts and calculus of probability including stochastic variables are held in the beginning of the course. Therefore we have prepared a booklet on probability, which is used as a reference book.

The textbooks, too, use the case-concept, as examples and exercises are founded from a few cases. In two of the books only one case study is used:

Survey sampling:
A census from a small town with approximately 1500 households.

Multivariate samples:
A market survey concerning the introduction of a new kind of savings bonds.

We had to adjust the textbooks to the purpose — an elementary introduction — and to the statistical background of the students. This means that our textbooks cannot be compared with most books on the same subjects, as they are on a more advanced level, implying a certain knowledge of statistics and mathematics. Let's therefore have a closer look at the contents of the books:

a. <u>Survey sampling</u>.
   - General description.
   - Getting reliable data.
   - Describing a sample.
   - Estimation of population mean:
     (point, interval and calculus of prob value: μ, $\mu_1 - \mu_2$, Δ).
   - Estimation of population proportions:
     $(\pi, \pi_1 - \pi_2, \pi_i - \pi_j, \pi_i = f(\theta_1,...,\theta_k))$.
   - Other sample designs (stratified, cluster and systematic).

The statistical theory presented is mainly estimation, but much weight is attached to the practical considerations: determination of population and frame, selection of sample units and getting reliable data (asking questions, handling error in data, non-response and checking the representativity).

b. <u>Quality control</u>.
   - General description.
   - Process control including control charts.
   - Acceptance sampling.
   - Statistical auditing.

The statistical theory presented is mainly on setting acceptance limits and on describing sampling plans by means of OC- and AOQ-curves.

The last fields are in some way all about the analysis of correlation between two or more variables, so a common title could be "statistical modelling". However, there are 3 different applications in business/economics, which can be seen from the procurement of data (census, experimental study, observational study).

c. <u>Econometrics</u>.
   - General description.
   - Regression analysis.
   - Time series analysis.

The regression analysis — estimation, assumptions, tests — and some of its special features are motivated and illustrated by examples from economics.

   d. Experimental design.
      - General description.
      - Analysis of various experimental designs.
      - Non-parametric methods.

The statistical theory presented is mainly the analysis of variance including estimation and testing, assumptions, test for homogeneity of variance and simultaneous confidence intervals. The general description includes pre-sentation of various designs and the principle of randomization.

   e. Analysis of multivariate samples.
      - General description.
      - Association: Measures of correlation, χ^2 tests and log linear models.
      - Explanation of response variables: regression analysis and logit models.

The new statistical theory in this field is the log-linear and the logit models.

IV. Computing (1985-). For the moment we are elaborating our own soft-ware for a micro-computer to handle the computing in survey sampling MISS©), and we have ordered SAS/qc for our mainframe computer to handle the computing in quality control.

Most dataset used in the textbooks and in the case studies are stored in such a way that the students have access to them. This means that the so-lution of most exercises can be done without any boring keying or com-puting.

5. Preliminary Experiences

The purpose of the effected alterations in our course in statistics was to be able to teach the students how to apply statistical techniques on the so-lution of some of the problems that they will meet when getting a job in business. In all we feel that we are now succeeding considerably better in doing so; at the same time we do believe that it can be even better.

The first response to the alterations came when the written examination was replaced by the 6-week case study work. The attitude towards statis-tics was at that time very negative and most students were very bad at statistics. The case study work came as a shock of reality, because the students at one time realized the relevance of statistics and their lack of ability to do statistical analysis. For most students the 6 week became therefore a desperate struggle to understand statistics better and in a new way, so they were able to present a reasonable solution to the case study. The evaluation showed that a good deal made it, some only partly — and some not at all.

The instructors of the case studies experienced a new and more positive contact with the students during the 6 week: from having an uninspiring audience without much response at the lectures to being consulted day and night by students asking relevant questions concerning their case study. However, there were one common complaint: Why are we not taught how to do such a case study?

When we began elaborating the new textbooks according to the new approach, we soon realized — as many have done before us — how difficult and time-consuming this work is.

One of the difficulties was to maintain the intentions in the new approach, in particular the principles:

"from application to statistical technique" (and not vice versa)

"only one dataset per application"

Another complication is that the textbooks are elaborated by different writers. Apart from problems on overlap and differing notation, it seems as if not all the writers understand and fully accept the new approach. The textbooks have for these reasons been published in provisional editions. At present only 2 books have been finally published: Probability theory and Survey sampling.

The time-troubles meant, too, that textbooks were published a few days before the start of the semester, often without the necessary proofreadings, thus giving rise to comprehensive corrigenda.

As one can see, the elaboration of the textbooks haven't been unproblematic. This threat to the success of the new approach was even strengthened by the following facts concerning the use of the textbooks:

- The fresh students are influenced by the negative attitude towards statistics among the senior students.

- The fresh students have no knowledge of the old approach and are therefore unable to see the improvements.

- More than half of the teachers are part-time instructors, who have not understood the new approach in full.

- For the students of the first year there was a bad division in the syllabus between the semesters, giving the students too much work in the first two semesters.

There have — as expected — been some complaints on some of the abovementioned points, but the objective seems to be fulfilled: There are virtually no students, who cannot see the purpose of learning statistical methods when taking a Bachelors Degree in business/economics; at the same time there are considerably more, who understand the essentials of statistics, and its applications to problems in business. This means that a

much larger group of students are now in sympathy with statistics. It's quite the impression that this are reflected in a much better learning.

It's difficult to measure the improvement, partly because it has been step-wise alterations, but the examination marks seem to be better now than before. The mean is higher and more students need not postpone the examination or present themselves for the examination a second or third time. In that way statistics is no more the "failing" subject.

We are now curious to know, if the students are able to apply their better statistical knowledge in the business/economics field, when leaving school. A first indication is, that more students voluntarily use statistical analysis in their final examination during the sixth semester: a 3-month case study work in business/economics. There are even a few students, who choose a teacher from our department as their main instructor for this work.

In all, the objectives of the alteration of the course have been reasonably fulfilled, and we feel that we know how to improve it further.

Quite another, but serious problem is the motivation of the teachers involved in the alteration of the course: As an employee at an institute of higher education in Denmark, half of your working hours should be used for teaching and the other half for research work. However, the alteration of our course in statistics is not regarded as research work — I was e.g. not able to get any funds for this conference from "The Danish Research Council" — so a good deal of the work has to be done on unpaid overtime. We hope — in spite of these circumstances — to be able to continue the alteration of our course in statistics, as we are convinced that it is possible to teach statistics in a way that will be of great use for students taking a degree in business and economics.

Appendix 1

Question:

To what extent are the subjects in your business study being useful in your job?

Answer:

Subject	very useful	of some use	of little use	of no use	useful-ness	sample size
Auditing	89	5	2	4	2.80	54
Accounting	64	23	10	3	2.49	144
Business Economics	54	38	7	1	2.46	169
Foreign Trade	55	25	15	5	2.30	20
Commercial Law	49	33	15	3	2.27	172
Finance and Credit	43	33	20	4	2.16	132
Organization	38	31	25	6	2.01	116
Data Processing	28	42	21	9	1.88	112
Marketing	36	29	21	14	1.87	115
Modern Language	33	34	18	15	1.85	97
Descr. Economics	13	36	42	9	1.54	173
Economics	16	29	40	15	1.45	173
Statistics	11	30	42	17	1.35	168

IN PERCENT

Usefulness = 3*(very useful)+2*(of some use)+1*(of little use).

Appendix 2

Question:

For each of the subjects in your business study, indicate - on the basis of your job experiences - whether the subject should have a higher, a lower or the same priority.

Answer:

Subject	higher priority	the same priority	lower priority	higher-lower priority	sample size
Data Processing	55	38	7	+48	144
Modern Language	53	41	6	+47	95
Finance and Credit	44	54	2	+42	133
Business Economics	40	57	3	+37	161
Auditing	42	52	6	+36	52
Accounting	40	56	4	+36	136
Marketing	36	59	5	+31	107
Organization	35	59	6	+29	108
Commercial Law	32	60	8	+24	159
Foreign Trade	39	45	16	+23	69
Economics	9	73	18	-8	156
Descr. Economics	10	63	27	-17	160
Statistics	6	62	32	-26	155

IN PERCENT