STATISTICS EDUCATION IN THE NETHERLANDS AND FLANDERS: AN OUTLINE OF INTRODUCTORY COURSES AT UNIVERSITIES AND COLLEGES

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This paper summarizes the results of a study into ways in which introductory Statistics courses are taught at universities and honors colleges in the Netherlands. In interviews, course coordinators described the teaching methods used, the student population, they assessed the developments in the statistics curriculum and considered future developments, focusing on Statistics for social science majors in their first year. These interviews form a part of a major study into educational and student determinants of course outcomes with respect to statistics courses in the Netherlands and Flanders. Regarding the first part of this study, i.e., educational determinants, the results show a diversity of teaching methods, group sizes (from 12 students to more than 500) and assessment tools. Statistical course content is, in general, equal across social science departments.

INTRODUCTION

Many first year students take Statistics as it is a compulsory course in most Social Science departments of universities and colleges, e.g., Universities consider Statistics to be part of basic academic skills, essential. Statistics is not a popular course with many students. They find the course difficult, they shy away from working with statistical software or with formulas, they think it is tedious, a lot of reading, calculating and computing variables and they do not like the examples or the books used. Little emphasis is put on teaching statistical thinking or reasoning. (Aliaga *et al*., 2005; Diamond, 2002; Garfield *et al*., 2002). Hence, many students have statistics anxiety, i.e., they lack confidence in their quantitative abilities.

Why is this? First of all most students do not take Statistics of their own free choice. Second, most Statistics courses are given as 'service teaching' outside their own field of interest and it is difficult to present subject matter that is relevant to the entire student group. Finally, most students feel that they will not use Statistics in every day life (Bradsheet, 1996; Sowey, 1995).

How can teachers help students overcome their fear of Statistics, ensure that students are stimulated to apply Statistical concepts and use it in every day life? How can Statistics be taught in such a way that students retain the acquired skills and knowledge for a long period of time? An answer to these questions can possibly be given by looking at student- and educational factors that influence the outcomes of Statistics courses.

Regarding student factors, Schau (1999, 2003) developed a model to measure students' attitudes towards statistics before and after completion of the statistics course. She found that affect, cognitive competence, value, difficulty, interest and effort influence student outcomes. Expectations are that this model can also be applied to universities and colleges in the Netherlands and Flanders. With respect to educational factors, strategies for teaching complex subjects such as Statistics are constantly changing (Moore, 1997). University teachers find new and better didactic models, educational and organisational settings change, as do government regulations. A few of the most prominent innovations consist of the emphasis on cooperative and active learning, small group sizes, interactive assignments and the use of real life research projects (Chance, 1997; Garfield, 1993; Roiter and Poiecz, 1996). However, the question remains to what extend these educational factors affect course outcomes.

HIGHER EDUCATION IN THE NETHERLANDS

In the Netherlands (and Flanders) the introduction to statistics has always started much later in the curriculum than for instance in the United States and Britain. [Most Statistics courses cover both Statistical and Methodological topics. Therefore, the title 'Statistics' does not always cover the content of the Dutch program completely. In this paper, I will only use the term 'Statistics,' even if a fair amount of Methods is included in the course.] It was not until the 1970s

that Introductory Statistics courses were introduced in the upper levels of the mathematics curriculum in secondary schools (Bakker, 2004).

Moreover, the implementation of the Bachelor-Master structure has constituted a drastic change in Higher Education in the Netherlands in the last decade. In an attempt to establish a better connection with existing Masters and PhD programs in Europe (and beyond), a number of Liberal Arts and Sciences Colleges have been founded during the last few years, offering a three year Bachelors program after which students can enrol in Masters programs across the world.

The recent organizational changes enable teachers to take a thorough look at the way in which they have been teaching. Hence, it is interesting to find out if and how these changes influenced the recent development of teaching methods for Introductory courses Statistics.

METHODS

Design and Subjects

The aim of this paper is to present an overview of possible *educational factors* that influence student outcomes regarding Introductory Statistics at Social Science departments in the Netherlands and Flanders and to see to what extent new insights have already been built into the current statistics curriculum. Regarding the *student factors*, a large scale survey will be conducted among Dutch and Flemish Social Science students. The latter results will become available in the summer of 2006.

In order to describe the current ways in which Introductory Statistics is taught, nine in-depth interviews were held among coordinators of Statistics Departments (8 Dutch, 1 Flemish university). These coordinators are primarily responsible for the *content* of Statistics courses. The interviews were conducted as part of a larger research project that currently is being set up in the Netherlands and Flanders.

A snowball sampling method was used to select respondents. Although this influences the external validity of the results, drawing a representative sample from the 14 Dutch and 7 (Dutch spoken) Flemish universities was never the primary goal.

Operationalisation

The in-depth interviews should provide answers to the question: '*How is Introductory Statistics taught at colleges and universities throughout the Netherlands and Flanders?'* The topic list consists of questions about the personal background and experience of Statistics coordinators, the current way in which courses are taught, student population, organizational setting, teaching methods and facilities, assessment, course-outcomes and future developments.

The interview transcripts were qualitatively analyzed using a system of coding and constant comparison, based on Grounded Theory (Wester, 1995; Glaser and Strauss, 1967).

RESULTS

Content

With the exception of one department, statistics is required for all first year students in the Social Science departments under study; it is considered to be a basic academic skill that every student should master. Five departments teach a combination of methods and statistics, four departments only teach statistics. The topics taught are the same across departments: descriptive and inferential statistics, introduction to hypothesis testing, some bivariate testing, univariate regression and analysis of variance. Sometimes, a number of nonparametric tests are discussed. In the combined Methods and Statistics courses a number of methodological topics is covered: measurement level, strategies for collecting data, reliability and validity. Two departments organize 'real life' research projects for their students.

Course And Learning Goals

According to most interviewees, the course aims at teaching students several types of research skills besides knowledge of statistical methods: doing research themselves and being able to read and interpret publications about research. Only four departments have formulated concrete learning goals for each topic. Some interviewees do not consider learning goals necessary, as they operate on a longstanding teaching tradition. Hence, they only make small

changes each year (e.g., book-edition, renewed assignments). In cases where learning goals have been developed they are also tested and evaluated for their content validity. Introductory courses at Liberal Arts and Sciences colleges are considered a challenge because of the diversity of entrance levels of the student population. These characteristics also make it difficult to develop clear and feasible courses for all freshmen. Therefore, sometimes the aim for alpha students is that they acquire a minimum of (passive) knowledge of statistics.

Population and Entrance Level

The student population consists of a majority of Caucasian women. It ranges from around 55% to a department where even 99% of the students are female. Most students come from high school or another college (known in Dutch as "HBO"). Honors Colleges and Universities differ in the sense that part of the student population in the colleges comes from an international background, and teaching takes place in English. According to five out of eight Dutch coordinators, the students' entrance level has deteriorated, partly due to the development of a 'study-centre' approach in secondary schools where the mastering of theories and formulae has shifted towards a recipe book approach away from basic theories. Combined with a decrease in weekly hours of teaching Mathematics at secondary schools, this leaves a lack of basic mathematical knowledge required for entrance levels of Statistics.

Class Size and Teaching Methods

Statistics courses are usually organised by a separate Methods and Statistics section. Statistics instructors meet regularly to discuss the content of their courses, but in most cases these meetings are not formalized. In four departments, *class sizes* are smaller than 30 (even as small as 12), five departments have student groups from 70 to 600 students. Cutbacks in departmental budgets over the past years have resulted in fewer teachers, hence group sizes became larger. However, most departments only teach Introductory Statistics once every academic year, despite the large number of enrolments. Departments with large group sizes often teach parallel (small) workgroups.

Teaching methods used include lectures, work groups, and projects. Course duration varies from 4 to 15 weeks, the shorter courses being part of a series of 2 or 3 consecutive courses. Students meet once or twice a week during two hours. Furthermore, introductions to SPSS are offered, mostly by means of workshops, labs or exercises. For large student groups, the lecture is the default teaching method. Besides these lectures, departments organize smaller 'workgroups.' Interaction between instructor and students is more intense for the smaller groups, resulting in a better insight in the students' progress. In four departments, small, interactive workgroups have been set up, two of which result from the 'problem based learning approach.' These departments also use electronic learning environments for course communication.

Assessment and Evaluation

Assessment and grading is very diverse: midterms, final exams, assignments, class exercises, individual papers and group projects. At six university departments grading is expressed in numbers (1 … 10), three departments use letter grading. The main test method used for six departments is one final exam with either open or multiple choice questions. It is possible to compensate this grade by handing in assignments and / or project papers. At three departments, the grade is a combination of midterms, assignments, attendance, participation and a project paper. Course outcomes (% passes) vary a lot across departments, from some 30% to almost all students. If grading is spread over a number of elements, the chance that students pass the course increases. All courses are quantitatively evaluated by means of a student survey. Some departments also use qualitative tools, such as a group discussion. Following up on the evaluation results differs among departments: sometimes the results are largely ignored; sometimes the courses are subject to a continuous innovation process.

Future Expectations

Most interviewees anticipate small changes in the near future, e.g., a growing emphasis on use of ICT-tools like Intranet and statistical software. This might even result in a decrease of

group meetings. The coordinators of large departments would like to work in small groups, make use of project groups and additional assessment tools. Statistics will remain compulsory.

CONCLUSION AND DISCUSSION

The aim of this paper was to describe the current teaching methods of Introductory Statistics at nine universities and colleges. The main conclusion is that there are a few striking similarities and differences between the two main organizational forms of university education. Firstly, group size varies from 12 to 500 students. Teaching methods also differ a lot, as the large groups mainly receive lectures and the small groups work in closer interaction with their teacher, resulting in a better monitoring process of the students' progress. Throughout all universities and colleges under study, the course content is approximately the same. Educational methodology has not yet entered the Statistics curriculum, the lack of learning goals is sometimes noticeable.

Contrary to expectations, so far the effect of the introduction of the Bachelor-Master system on the development of Introductory Statistics is not yet visible. Only in small scale colleges, innovative teaching methods have penetrated the Introductory Statistics courses, where collaborative and interactive methods are a part of day to day teaching. This could be due to the fact that the colleges are very young and still developing their methods and materials, making use of the latest didactical developments.

As this study progresses, answers should be found to the question: "*What is the effect of educational and student factors on the course-outcomes with respect to introductory Statistics courses at Universities and colleges?*" Regarding student factors, a survey will be organized among the student population of Introductory Statistics courses at the departments under study. Besides adaptation of the SATS questionnaire (Schau, 1999, 2003) to the Dutch and Flemish situation, the interview results described above will be used to develop questions for the educational aspects of each institute. The aim of this study is to develop recommendations in order to teach Statistics in such a way that students retain the acquired skills and knowledge for a long period of time and will know how to usefully employ Statistics in every day life.

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