AN EXAMPLE OF ASSESSMENT BEING AN INTEGRAL PART OF A SERVICE COURSE

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When designing a new basic course in statistics for students in Environmental Engineering at Lund University, our aim was that assessment should be an integral part of the course. We found that there were several factors to be considered, such as how the assessment should be in line with the goals of the course and with the teaching method. One piece of the assessment is a major project and we discuss how we have organized it to give timely and constructive feedback to the students. In this course, the students have their own personal computer available at each lesson and at the exam. This opens up for new possibilities when assessing student learning but also create new problems. A number of pros and cons of using computers at the exam are given.

INTRODUCTION

Assessing student learning in statistics has several purposes. The obvious one is to check that the student has obtained the stipulated knowledge and met the goals of the course. But the assessment could also be used to guide the students in their work, give them proper feedback and improve their learning. Ideally, it should also be designed to give the teacher an opportunity to evaluate the course. With this in view, the units of assessment have to be integral parts of the course and in line with the teaching method. Each item of the assessment has to be motivated by the goals of the course and, vice versa, should each goal hopefully be assessed.

When designing a new basic course in statistics for students in Environmental Engineering, our aim was that assessment should be an integral part of the course. This paper describes the results from this process. We decided to use cooperative learning as teaching method. It was then extra important to choose a suitable method of assessment that would benefit of the positive effects of cooperative learning but on the same time assess the students individually. Since the students are supplied with their own personal computers, we also wanted to take advantage of this in the course, and thus in the assessment. How should then the assessment be designed?

THE COURSE

The students in Environmental Engineering at Lund University have a compulsory course in basic statistics in their third year of studies. They have a background with courses in physics, ecology, water resources as well as in basic algebra and calculus. The statistics course is scheduled for 70 hours during 7 weeks. One third of the course consists of probability, one third of basic statistical methods and the last third of regression and a small introduction of time series. Every year 50-60 students attend the course.

We use the teaching method of cooperative learning where the students, in groups of four, study the literature and work with exercises from a given agenda. A teacher guide 7-8 groups during a lesson. There are few lectures. Of the 70 hours, 52 are lessons, 14 hours are lectures and during the remaining 14 hours the students work with a project. Each student has a personal computer, supplied by the university. In this course, the students use their computers on nearly all lessons as well as when working on the project and on the exam.

The course, which probably will be the only course in statistics these students will attend, has a clear focus on environmental data. Most tasks in assignments, projects and exam, as well as in exercises, have a focus on problems and data connected to environmental statistics since this is the major application of statistics that the students will meet.

ASSESSMENT – A MIXTURE OF UNITS SPREAD THROUGHOUT THE COURSE

The assessment consists of three different elements: individual assignments, project and an exam. Figure 1 shows how the assessment is scheduled.

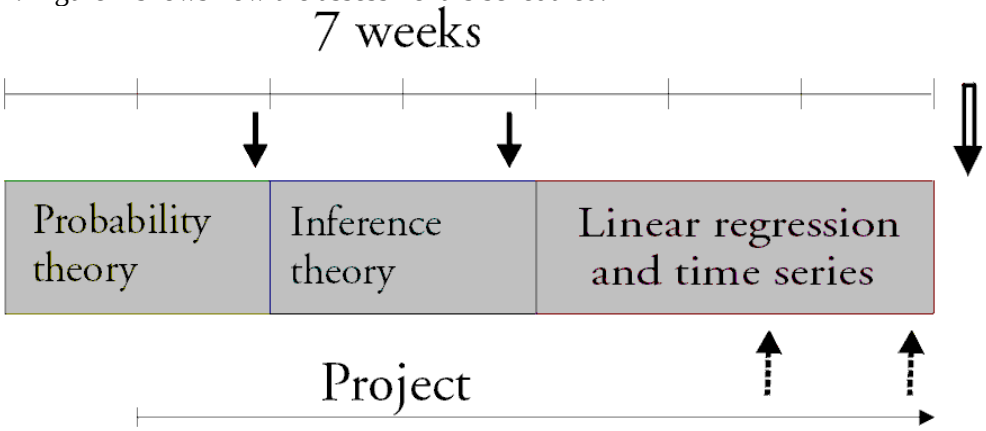

Figure 1. Organization of the assessment in the course: assignments (arrows in the first part of the course), project (dotted arrows) and written exam (double arrow)

- *Self-reviewed assignments.* Twice in the course, after the module of probability and the module of basic statistical methods, the students get assignments. Each assignment consists of 3-4 tasks of "ordinary problems" normally found in textbooks in probability and statistics. The students are recommended to them individually. The teacher "ticks off" that the assignments have been done but do no mark them. The solutions are thoroughly presented and discussed at a lecture where the students self-review their answers. In this way there will be no extra workload for the teacher. Sometimes a few solutions are randomly chosen and studied.
- *A project* runs through the whole course, starting after one week. 20 % of the scheduled course (14 hours of the total 70) is devoted to the project. The students work in groups of two. During the first part of the course, a teacher is available at 8-10 hours. In the sixth week the students present a report which will be peer-reviewed by another group and discussed (2-4 hours) before handed to the teacher. A discussion between the teacher and the group, and afterwards possibility to rewrite/redo (2 hours) are also included within the 14 hours. In the project the students are working with a larger environmental data-material. It could be measurements at a site where sulphur dioxide in the air is measured and its origin traced. The students are to tackle open-ended questions as "Is there a trend in data during the observed period?" or "Is the concentration of sulphur dioxide higher when the origin is from country A compared to country B?" Half the group of students is working with this project while the other half is studying an equal project concerning emissions of nitrogen oxides from a warming-pan heated by natural gas. When peer-reviewing reports, a group will read a report on a project they have not worked with themselves.
- At the end of the course there is an *individual written 5 hour exam*. The students use their personal computers at the exam. Some of the questions are "common" where the students calculate and give the answers on paper. Other questions involve data-materials which are given to students using memory stick. Then students present additional figures and comments in a word-document which is "handed in" at the end of the exam.

ASSESSMENT IN AGREEMENT WITH THE GOALS OF THE COURSE

The assessment should be a natural part of the course and not only "something scaring that comes at the end". We have seen examples of courses where the students have only concentrated on studying problems on old exams and thereby developed a "hidden syllabus" for the course. As a preventing measure we have been anxious to relate the goals of the course to the assessment. Each item in the assessment process should be motivated by the goals and vice versa.

For this course, which is probably the only course in statistics that these students will attend, focus is on understanding and interpretation of data, not on formal calculations. We especially focus the relation between the practical situation, data, and the statistical model for data. Besides that students should be able to construct simple statistical models, we train them to critically study the model and use the results from the statistical analysis to answer the original questions. The computer should be a natural resource in the analysis, not only for fast calculation and visual aid, but also for evaluation of distributions and models through simulations. The students' attitudes towards statistics are of primary concern. They have to realize the necessity of understanding variability and statistical methods when studying environmental data or planning to collect data. We also want to train the students in oral and written communications in statistics.

Table 1 below shows how we relate the goals of the course to the different items of assessment. Some comments on the table are given below.

Table 1
How the assessment is related to the goals of the course

	Assignments (individual)	**Project (in group)**	**Written exam (individual)**
Attitudes	X	X	X
Formal calculations	X		X
Interpreting data		X	(X)
Constructing and critically studying statistical models	(X)	X	X
Using computers		X	X
Written and oral communication		X	

If the students don't understand why they are learning statistics they will probably forget the course when it’s finished. We have worked hard with the attitudes towards statistics and therefore most questions in assignments, projects and exam, as well as in exercises, have a focus on data and problems connected to environmental statistics.

A couple of years ago we made an analysis of student's answers on exam, using the SOLO model. It revealed what we suspected: the students were week on formal calculations. We therefore introduced the individual, self-reviewed assignments where the students train individually on calculations and it had the desirable effect. We think this is a good example of how the assessment can be used by the teacher to evaluate the course.

ASSESSMENT IN LINE WITH THE TEACHING METHOD

When choosing method of assessment it is important that it is consistent with the teaching method (Hagelgans et al. 1995). We emphasize that the students should work in groups during the lessons but on the other hand we would like to assess them individually. There could be a problem: how could you assess the individual student at the same time as you wish to benefit of the positive effects of cooperative learning? A relating problem is the following: When students work in groups, discussing and calculating together, they may be uncertain on their individual capability to solve the problems. We have tried to develop an assessment, where individual

activities and group activities are mixed. Assignments and final exam are on individual basis, work and discussions on project in groups. The lectures where the assignments are discussed are very appreciated by the students. They come well prepared and are very active with questions and comments on these occasions. Most of the students appreciate working in groups but at the end of the course, when the final exam is coming closer, there is a tendency of some students preferring to work on their own on lessons.

Assessment is being thought as the main factor when directing students work. In this course the teaching method of cooperative learning and the organization of the assignment "force" the students to follow the time schedule of the course. There is high attendance at the scheduled hours and very few drop outs. All students fulfill assignments and the project. Approximately 75 % pass the exam immediately after the course and after a second opportunity approximately 90 % have finished the course.

TIMELY ASSESSMENT AND FEEDBACK

A large workload on the students is thought of promoting a surface approach to learning (Biggs, 1999). The students get so frustrated by all the things the have to do so they have no time to reflect on what they are learning. This indicates that assessment should not only be carefully chosen but also be timely so workload is spread over the whole course. It should have clear goals and clear criteria. With a correct amount of guidance it will be more of an opportunity to learn instead of something being checked off. Feedback to the students should be constructive and timely (Chance 1997).

Starking (1997) discusses several aspects when assessing students projects. In our course, we give the students timely feedback when they work with the project. Since it runs nearly throughout the course, the questions in the project echo the syllabus of the course. When for example you work with confidence intervals on the lessons, you see an application in the project the same week or the week after that and could repeat the concept. You could discuss it once more with your group mate or with the assisting teacher and get feedback from the teacher on your own oral or written interpretation of the concept. When the project report is written, another group reads and comments on it. Since the other group has not worked with the same project you have to describe the problem and the analysis explicit. The feedback from a peer-reviewing group could be harsh but is often appreciated. In the final moment the teacher reads and gives written comments on the report. When the reports are returned, a scheduled two-hours lesson is devoted to discussion between the teacher and the group, and if the students have to redo or elucidate something in the report it is done this lesson. A great advantage of this schedule is that when the course ends after seven weeks all students have finished their projects and no latecomer will turn up with a forgotten report several month afterwards. It is also appreciated by the students that the feedback from the project and the discussion with the teacher is before the individual exam.

Criteria for peer-reviewing the reports are given to the students, including a list of items to be "checked off" on the report. This list contains items of both statistical issues as well as more general matters of how to write a good report. Even though the list is thought as a help to the students in the peer-reviewing, it also becomes a criteria for their own work.

We do not give personal feedback on the individual assignments, partly due to lack of resources but partly to emphasize the importance that the student takes care of her/his own learning. We have tried lectures where the students peer-review the assignments but it was not popular among the students.

USING PERSONAL COMPUTERS AT THE EXAM

When a student starts at the program he or she is supplied with a personal computer. This is heavily used in the statistics course where the students use the computer and the software package Matlab on every lesson. Approximate 2/3 of the exercises in the course use computer for simulations, graphics, analysis and calculations – often in a mixture of all three of them.

The students use their personal computers at the individual written exam in the end of the course. Some of the questions in the exam are "pencil and paper" tasks. Other questions ask for simulations or use data-materials which are given to students using memory stick. Then students present additional figures and comments in a word-document which is "handed in" at the end of the exam.

Taylor et al. (2000) discuss issues of examination design, administration, and evaluation of computer testing for a data analysis course. We shortly list some of the pros and cons we have found by using the computer on exams in the described way.

- (+) There is a possibility to ask a different kind of questions compared to an ordinary exam, and thereby assess the students on other goals.
- (+) The exam is given in same form as the lessons on the course, and therefore motivates the students' work during the lessons.
- (+) The exam is echoing a future working situation for the students where a computer is always available and used in the analysis. We are eager to give real-life problems and data at the exam, as well as on the exercises.
- (+) and (-) The students save their results and comments from the exercises at the lessons on their computers, and are recommended by the teachers to do so! Other teachers have questioned this since they argue that the students then have the results on their computers. We argue that the questions on the exam should assess more basic ideas than routine questions. Even if the student has made careful notes of the answers of the exercises you have to be familiar to the concepts to be able to use your notes when answering a new question. Besides, making their own comments in their own words is a perfect way to learn.
- (+) and (-) Using nontraditional exam need nontraditional evaluation of the student's answers. There is an ongoing discussion between teachers concerning the criteria of evaluation.
- (-) It's more time-consuming for the teacher to construct this type of exam compared to an ordinary one. There is also extra work in the administration of the word-documents.
- (-) The risk of students connecting each other through wireless network during the exam has to be eliminated.

Summarizing, we find the positive effects of using computers on the exam predominating.

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