Learning Statistics – in a web-based and non-linear way

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ABSTRACT

Have you thought about why most teaching is linear? Do you know what non-linear learning means? Do you use web-based learning? And have you ever thought of combining web-based learning with "standard" university teaching such as lectures, problem based learning etc.? Students nowadays are very different from one another. They have different prior knowledge and different learning styles so it is a challenging task to teach them all in the same way. Furthermore the world of statistics has become so huge that it is impossible to cover everything. The structure imposed by the Bologna agreement gives a greater mobility which is good for both the students and the universities but leads to even more "inhomogeneity" at the courses. One possible solution is to combine traditional university teaching with web-based learning organized by using learning objects in a non-linear way. This means that the students can design the course – or a part of the course – so that it fits their individual learning style and their prior knowledge. Some prefer to look at examples first and afterwards look at which theories it is based on. Others want to do it the opposite way. Some wants to work with the problem themselves at first, then look at some pictures which show the essential parts and then read a text or listen to a spoken explanation. There are many possibilities – only your fantasy limits you. Learning objects are easy to modify (in contrast to writing a new book) and it is easy to use learning objects made by others and in this way make the job as a teacher both easier and more fun.

Of course the non-linear way of organizing learning objects can also be used in stand-alone web-based courses and in many other contexts as e.g .in school education and continuing education.

1. Introduction

Teaching statistics at universities is a complex task – primarily for two reasons. Students are very different with respect to both their knowledge and their learning styles. This inhomogeneity is difficult to cope with when using the usual university teaching which primarily consists of lectures and exercises. Even if one uses more "modern" learning techniques such as project work, problem based learning or team based education it is difficult to ensure a satisfactory learning environment for all students.

Faced with a new generation of students who are used to exploiting the possibilities of the computer, we need a new type of education that will reflect a rethinking of content, form and duration. In the future, education will be in the form of "voucher systems". You get a set of vouchers and use them to attend the specific chunk of a study programme you need whenever and wherever it suits you. If the providers are to meet these requirements, the task of developing new courses and tailoring these to new students must be manageable.

We therefore, in this paper, propose a new type of courses. These are structured around learning objects, short complete education sessions, which may be combined in various ways according to the

student's interests and levels. We combine the learning objects with blended learning and the ideas are tried out in research-based education in applied statistics. Working with learning objects gives a wide range of flexibility for both the course providers and the users. E.g., the structure makes it easier to suit different learning styles and the reusability makes it easier to make new courses tailored for new students.

2. Different prior knowledge and different skills

Coming from high school students are very divers and during their education they become ever more different with respect to knowledge and skills. Furthermore the world of scientific knowledge has become so broad that it is not possible to cover everything. In earlier times courses at a university fitted in with each other like pieces in a puzzle but this is not possible anymore – now there will always be some space in between the courses and the problem is then how the students can be able to fill that space.

3. Different learning styles

"Most people of college age and older are visual, while most college teaching is verbal - the information presented is predominantly auditory (lecturing) or a visual presentation of auditory information (words and mathematical symbols written in texts and handouts, on transparencies, or on chalkboard). A second learning/teaching style mismatches thus exists, this one between the preferred output modality of most students and the preferred presentation of most professors." (see Felder and Silverman (1988)). The citation states the problem which we are faced with very clearly – it is not enough to do university teaching the way we have always done it.

Felder et al (see e.g. Felder and Brent (2004), Felder and Soloman (working paper)) introduces 10 different learning styles. A corresponding set of teaching styles exist but they will not be mentioned here. See the references for a description. The learning styles are:

1. Active learners
2. Reflective learners
3. Sensing learners (Sensors)
4. Intuitive learners (Intuitors)
5. Visual learners
6. Verbal learners
7. Sequential learners
8. Global learners
9. Inductive learners
10. Deductive learners

It is outside the scope of this paper to discuss in detail what is meant by them but it is intuitively clear that in an ideal world we should have many parallel teaching sessions in order to meet the needs of our students.

4. Web-based and non-linear Learning

A possible solution to these requirements could be web-based learning in a non-linear way. So what do we understand by web-based learning and what does it mean that it is in a linear way?

5. Web-based learning

Searching the internet shows lots of examples of web-based learning but most of the examples are "books transformed to the internet". Real web-based learning is not that common. Many books and papers discuss different ways to organize web-based learning (see e.g. Davidson-Shivers and Rasmussen (2006)).

6. Non-linear learning using Learning Objects

Usual learning/teaching is linear. You read a book trying to understand every little piece of information sequentially, beginning at page one, and ending at the last page, or you watch a lecture following the teacher's progression. But does it have to be so? Cognitive research shows that we do not always learn best in that way (see e.g. Jensen (2005)).

Instead of doing the learning/teaching in a linear way it could be done non-linearly by letting the students decide when and how to work with the different topics. In order to do this the learning material – what ever it is – has to be divided in small parts which can be "used" independently of each other (see the figure below). These small parts are called learning objects and represent a relatively new method of subdividing courses into smaller modules. According to http://wiley.ed.usu.edu/docs/encyc.pdf, a "Learning Object" is defined as follows: "Any digital resource that can be reused to support learning. The term "Learning Objects" generally applies to educational materials designed and created in small chunks for the purpose if maximizing the number of learning situations in which the resource can be utilized".

When dividing the learning material in small parts it should be remembered that it is not just a question of cutting it up into small pieces – like dividing a book into chapters. The learning objects should be self-contained, meaning that it should be possible to use the objects in what ever order the student may like. This imposes many constraints and is quite challenging. Furthermore it is "allowed" and even desirable to explain the same topic in many different ways to suit student needs. Several learning objects could be made on the same topic – just doing it in different ways. Here "different ways" means using different techniques (figures, examples, text, video, speaks etc.) and explaining on different levels.

Using learning objects in the way described above can either stand alone, or it can be combined with face-to-face teaching/learning to give the students better competencies and to fill gaps between courses.

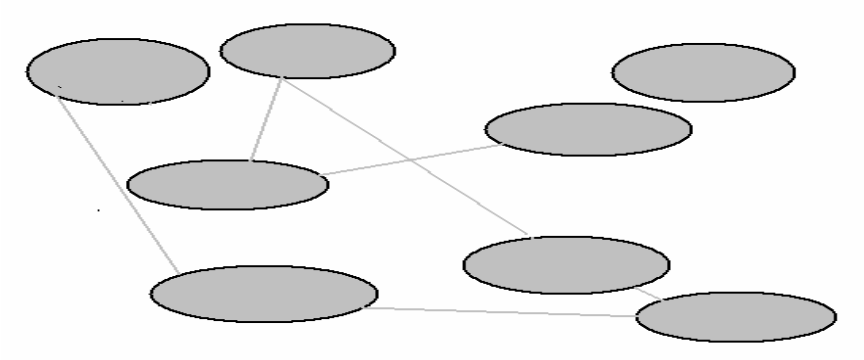

Figure 1: The ovals represent the learning objects. Each student chooses her own path – represented by lines – between the objects, and may skip some objects completely. It is easy to go back and fort between learning objects, and to a large extent they can be used independently of one another. Typically different students will choose different paths.

7. HEROS – an example

We have developed a system called HEROS (Higher Education Reusable Objects in Statistics). The system is made in Lectora, an authoring tool made by Trivantis (http://www.trivantis.com), and uses Hypergraph - a hyperbolic graph - (http://hypergraph.sourceforge.net) as a tool to make an overview of the learning objects available in a given course or in many courses all together. HEROS is built around the hyperbolic graph which shows all the learning objects in the course. If you click on a part of the graph the part will be enlarged in order to make the navigation easier. If you click on a learning object you go into that object and can work there as long as you like and visit it as many times as you want. All learning objects include a test so that you can test whether you need to jump into the object at all, and if you do you can afterwards check if you have "made it". In HEROS we have tried to implement the ideas discussed in this paper. Our first course is an introductory course in statistics, made for continuing education in a global company, aimed at upgrading employees around the world. With a few modifications it could also be used in university teaching. It is outside the scope of this paper to describe the different techniques and features used for making the learning objects and the philosophy of trying to build in active learning as well as company relevant material. A demo version of HEROS will be published at http://www.imm.dtu.dk/~hero.

8. Discussion and Conclusion

The ideas outlined in this paper are a first step towards defining a new concept of teaching. We need to do much more experimental work to fully understand the potential and limitations of the suggested frame. A further possibility is to combine the ideas with the CDIO principle (see Crawley, Malmquist, Ostlund and Brodeur (2007)) Moreover the ideas can be of course be used in other areas both outside the universities and outside the area of statistics.

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