Can we teach statistics to undergraduate students using the World Wide Web?

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Abstract
This study is examining the use of technology to replicate the traditional way of teaching statistics to an undergraduate group of students in the Department of Education. The statistical course covered descriptive statistics at an undergraduate level and the www was used for the teaching purposes. The group of students in this study was not homogeneous on their knowledge of technology use.
The present study gives evidence that teaching statistics using the www can take its place in a traditional university setting as fewer lecturing hours were needed and students mastered the subject well.

Introduction
New technologies (NT) have induced certain changes in the present educational system. They have also affected the teaching and learning process. Internet as an interactive technology has changed the way students assimilate information. Students who learn a new subject, using NT and mainly the Internet, have to develop abilities in analyzing, searching and synthesizing new information. The way in which students approach their studies and the quality of learning outcomes have been related to how the students understand the subject (Trigwell & Prosser 1991). Educators and technologists are interested in finding the appropriate way in which to use information technology in the teaching and learning process. The Internet and more specifically the World Wide Web (www) are new educational media for many teachers. Although many teachers have browsed the www, only few of them are using the www in the classroom learning activities. Nowadays, using www for teaching and distance learning, technology is always present. In practice, we can see that there is a tendency in some universities to use more and more the www for distance education techniques and in others to incorporate information and communication technologies in order to improve learning. Research concerning the use of technology in education, generally states the technological advantages and their impact on teaching and learning.

Information and communication technologies (ICT) have been a useful tool in the teaching and learning process. Specially, ICT can be either as an object of study, or as a tool, or as an independent learning resource that replaces the teacher, the peers etc. (Moonen 1995). Rockman (1992) states: “Because no one technology can do everything…, educational technology is most effective when used in that specific combination with other technologies and instructional approaches. So, the key to the future is to incorporate technology into regular classes and trying to avoid feelings of frustration and confusion about the use of computers because these feelings are associated with lower job satisfaction and individual performance (Murrell et al 1993).

Turoff (1999) and Pange (1998, 1999) suggest that although some people still consider the remote education as a poor one, due to its earlier difficulties, nowadays technology may improve not only face-to-face classes but also distance education
provided by universities. In a recent study, Jafari (1999) suggests that a web enterprise system offers to universities and colleges a cost-effective and easy-to-use solution, producing generally an effective learning environment. But Martens (1998) states that distance education is problematic when a student has difficulties in assimilating educational material. Moreover, the consideration of the quality of academic provision and especially the characteristics of the learning environment and the students’ characteristics in an electronic learning environment are very important and they have to be examined in an distance education system (Laurillard 1993, Schuyten et al 1998 and Turoff 1999). Putting these ideas together it is obvious that in a distance education system when we consider technology as educational tool we have to consider it in relation to the problems created to the students.

So, in an educational system where we would try to put together the positive aspects of educational technology setting with a distance education system, the use of email has not to be neglected. The use of email as a distance education tool is now widespread in higher education and according to Gilbert (1996) ‘course-related use of email is becoming the single most powerful force for integrating information technology into teaching and learning’. The advantages of using the email in a distance education system according to Smith (1999), are summarized in the following points:

- Submission of the coursework could be direct to the tutor
- Coursework need to involve little or no paper material
- Once prepared the course material for email use it could be delivered many other subsequent times
- There is no attendance requirements of the students
- Students can work at their own pace and time
- All material delivered by email could be stored for future use of the tutor
- Asynchronous and fast transmission of information is established
- There was no face-to-face contact between tutor and students

In a statistics course it is proved that many students lack of understanding of basic concepts (Garfield 1995). Moreover, there is a structural relationship between students’ conceptions of statistics and their approaches to the learning. So, the introduction of ICT to the teaching of statistics is considered as a useful tool to the learning process (Pange 1998).

This study investigated the effectiveness of a www learning environment in the teaching of statistics using also the email method as a distance education part of the course. We also evaluated the students’ performance in this web learning environment. For the purposes of the study the ICT was used as an independent learning resource.

**Materials and method**

In this study a www technology learning environment was used to transform the traditional way of teaching in a course of descriptive statistics to a self-selected group of 20 undergraduate students in the Department of Education last year. These students were attending their third-year undergraduate program. All students were taken this course for their first time.

This course on statistics was considered to be as semi-difficult due to the lack of basic knowledge in mathematics and statistics of the students. On the other hand it is quite clear in Greece, that the mathematical and technological background of
students in most of the Departments of Education, is heterogeneous. So, the need of an extra seminar in basic mathematics and statistics was apparent.

This course in statistics covered mainly the theory of descriptive statistics, but apart from its theoretical part there were examples, exercises and homework. All that material was in the Department’s Internet site. This material was written in Greek as some of the students did not know English very well and they were not able to retrieve information from the Internet. Moreover, all students were free to search for information at any Internet site they liked with a relevant topic on descriptive statistics.

Paper copies of descriptive statistics were also copied and distributed to students at the beginning of the course upon their request.

During the first month of the term (winter term), apart from the extra seminars, once a week, a meeting between the lecturer and the students was held to go over difficult material in statistics, answer questions and show examples. Students were free to attend or not these meetings. For an extra help to the students, at the beginning of the course, communication in between lecturer and students was established via email.

During the other three months of the course, once a week, the students were free to have a communication with the teacher either face-to-face or using the email. In these meetings students discussed the material on descriptive statistics they read from the Internet and solved real data statistical problems.

At the end of the course all students submitted a work in descriptive statistics. They were free to handle it to the teacher, either by email or on a paper copy.

For the better application of this web teaching process each student in the course was given a unique ID and password to access the course material any time. Students used only the computer terminals of the ‘Computer Center’ of our University.

Results and discussion

Teaching statistics towards a new pedagogy. Was it easy?

According to behaviorist descriptions of the learning process, only those outcomes which are observable or measurable are considered. Learners in this teaching style are encouraged by rewards and inhibited by punishments (Black 1995, Skinner 1953) The learning-teaching system based on these principles, is teacher centered, where the context in which learning would take place are often ignored and learners are given little opportunity to develop perspectives or undertake tasks (Brown 1995, Wilson 1997). This teaching system for statistics, was used for years in many Universities, where the teacher was the ‘master of knowledge’, with inflexible curricula of statistics and where collaborative learning was not the common case.

In contrast, constructive learning focuses on the individual’s learning cognitions and experiences and not on the discovery of an external objective reality (von Glaserfeld, 1996). In this learning system, learners create their own knowledge and understanding through active engagement in real-world tasks using actual tools. According to Piaget (1971), the knowledge is real and constructed. So, there is a cognitive development determined by biological maturation. This fact is less accepted by many constructivists. Other constructivists also built their own understanding of constructivism, so there are as many varieties of constructivism as there are constructivists (Crawford 1999). Using this teaching system in our study, the teacher orientated his/her conceptual construction process and the students had part to the learning process constructing their own knowledge mainly through collaborative learning and social engagement.
In our study, at the beginning of the course, only ten students (50%) knew well how to use computers and www. So, these 10 students, had a 6-hour intensive seminar on computers and www. These students had also the assistance of their classmates. They worked in small groups of two or three students many times during the week. These groups of students were not fixed and the students were able to move from one group to the other. The synthesis of these groups was generally the following: one student who knew the www well and one or two students of those who had no experience on computers and www. At the end of this short seminar all students were able to use www and three of them said that they were interested in learning more and specially how to create their own web pages. One of these students, worked alone using only the information available at the Internet and at the end of the semester she wrote an essay in Greek, describing the way one can create its own web pages.

So, in this teaching program of statistics we started using an active style of learning where the students took control of the technology. Furthermore, the students had no problems with other students in making mistakes. They also encouraged in a collaborative learning and they had the chance to do something extra in statistics than the teacher was teaching them in the classroom. The learning environment at this stage of teaching was user centered, the error recovery was supported, the learning material was structured and the students started on learning the www as quickly as possible.

The statistical course

In this group of students, it was found, after a completion of a set of questions concerning basic statistics, that the majority (16 of them) had problems in understanding basic statistics for example the median, the analysis of variance, the normal distribution and the idea of testing a hypothesis. So, we decided to give them four extra lectures in mathematics and statistics. Although all students had finished a previous course in basic statistics, they had a lack of understanding of the basic statistical concepts. So, it was established an email communication in between the teacher and every student, in order to find out their particular problems in statistics. From this study it was found that no student lacked the ability to manage the email system. We decided also to use the email communication because some students, when they are in class they feel uncomfortable to answer questions concerning their previous knowledge on a subject.

Then we made a list of the topics which had to be covered in a basic mathematical and statistical seminar. The lecturer, apart from the lectures she gave in the class, tried to introduce the students into the way of getting information from the www about basic statistics. So, the lecture material was not only in paper copies but also in www in a simplified form in the Department’s site. A number of in-class practical problems and handouts were also used. On the completion of this short course in mathematics and statistics, all students were able to understand basic statistics, use the www, solve a statistical problem using real data. Moreover, they became a homogenous group of students.

Problems searching in the web

In our study we observed some problems of our undergraduate students
attempting to find statistical information on the web. Although students learned quickly how to use features of the browser to surf the www, the navigation for getting the right statistical information was difficult and frustrating. Searching the www by the keywords ‘descriptive statistics’, ‘statistical inference’, we got a great amount of sites, many of which were not relevant to the subject. On the other hand, the amount of time needed for searching these web sites was quite a lot, so our students either preferred to search the first list of web sites that appeared on the screen or they randomly selected to retrieve information from the list of the relevant web sites. Another common problem reported from our students, was the ‘world wide wait’ so many of our students had lost their ability to stay focused.

The course of descriptive statistics

The main course of descriptive statistics started when the group of our students was homogeneous in all aspects of statistical and mathematical background. In order to encourage the students’ active participation during this course, the time spent in lecture was gradually minimized and increased:

a) individual work/study using the www and
b) discussion using the email.

Using www for teaching statistics was a quite difficult task for the teacher. For this reason, the lecture material presented in www was split into ten separate lectures. These lectures were in a simplified form with:

• the statistical problems well defined,
• the relevant exercises and
• the set of homework assignments ranging in difficulty from low up to high.

During this part of the course I found that individual work using www made students feel more comfortable and helped them to:

a) understand the theoretical concepts of statistics,
b)solve statistical exercises and
c) get an idea of their level of achievement.

Moreover, students were not obliged to attend the lectures on regular basis and they had more free time. Discussion using the email helped them to have an immediate contact with the teacher and also to create groups of students with similar interests. So, students gradually formed homogeneous groups consisted of 3 or 4 students and they asked me to give them an extra project in statistics for team work.

At the end of this course, we asked them to answer a test in descriptive statistics. Evaluating their answers in this statistical test, we found that 75% of students answered all the questions correctly and 96% students finished their project in descriptive statistics a month earlier of the end of the term. Moreover, from the answers of the projects it was found that the students used a lot of information in statistics written in our web site and in other web sites. This implies that the students were able to use statistics and www for future works. They were also so satisfied working cooperatively in small groups using www so they asked me for a similar course in the next semester. Only one student wanted this course to be lectures only, and none wanted to be delivered entirely via www.

Moreover, it was found that the number of lectures needed to cover the course were less by almost five hours than the total number of hours estimated at the beginning of the course.

At the end of this course, we can conclude that if someone wanted to start now a similar program in statistics he/she should not has to forget to take into account the
following points

- The group of students has to be homogeneous
- All students have to like working using NT and email
- The teacher has gradually to minimize his/her presence in the classroom and allow students to collaborate
- The teacher has to pass to students the belief that they will learn something useful if they will learn statistics.

So, I plan to design a follow-up questionnaire to get information during the next years concerning the students use of statistics in their future work and whether or not these students have incorporated the statistical techniques into their knowledge and in real data problems.

It is important that this learning approach modified the traditional way of teaching by changing the teacher’s role from a primary knowledge source and knowledge transmitter to a mentor in learning process.

In conclusion, the present study gives evidence that www and email in a learning environment gives to students positive perception of learning. The web was used in this study as an independent tutor and the students learned how to use technology for learning. Furthermore this course was a mixture of a distance education, teaching with technologies and traditional teaching enabling at the end students to understand descriptive statistics easily.
References

- Piaget J. (1971) Structuralisme Routledge, Kogan Paul