Batanero, C. (Ed.), Training Researchers in the Use of Statistics, 139-145.

Printed in Granada, Spain.

TAE RIM LEE

TEACHING BIOSTATISTICS TO MEDICAL PERSONNEL WITH COMPUTER BASED SUPPLEMENT

It has become increasingly evident that the interpretation of much of the medical research in health sciences depends to a large extent on statistical methods. For this reason, it is essential that students in these fields be exposed to statistical reasoning, data analysis, and computation early in their careers. With the current advances in the methodology for data analysis we can take advantage of the highly developed computer software. Nowadays the internet provides rapid feedback to the student and dissemination of the latest research information. This paper focuses on the teaching of biostatistics to health professionals with computer-based supplements; courseware, digital library of TV lectures on SAS and interactive communication through the Internet.

1. INTRODUCTION

There is an increasing need for health-care professionals to use statistics in their master's thesis or other research, and nowadays statistical analysis can be easily performed using a statistical package (Binyavanga, 1998). Many medical journals require a high level of statistical sophistication from their authors (Altman,1991, 1994; Hand, 1994, 1996). It has, furthermore, become evident that the analysis of much of the research in the health sciences depends on highly advanced statistical methods.

These facts increase the requirement for biostatistical understanding among health professionals in order to choose the appropriate statistical method and to interpret the results produced by the computer (Korea Biometric Society, 1994; Svensson, 1998). Use of computers is encouraged in teaching to allows the student to concentrate on the interpretation of the analysis rather than on arithmetic calculations. (Phillips, Francis, & Hutcheson 1998; Beur, Richards, & Lancaster,1987). Teachers can pay less attention to students' mathematical calculations by using statistical packages. Algebraic notations in lectures and textbooks has also been simplified to reduce the mathematical skill needed from high school graduates in a statistics course.

On the other hand, most major medical research projects involve a tremendous investment in time and money and result in a large body of data, that need to be analysed with computers. For this reason, in my courses, I allocate 50% of the lecture time for computer practice with SAS and Excel, and students are introduced at the same time to SAS with television lectures that serve to demonstrate computer work and the interpretation of output (Johnson, Johnson, & Stanne, 1985).

In Korea, statistics courses using more flexible modes and newer technologies such as the World-wide web, CD and cable television programs are being offered and these recent developments in technology can potentially lead to great improvement in teaching statistics. With the boom of the Internet, a computer-based learning of statistics has attracted particular attention from both students and researchers.

This paper outlines a flexible method of teaching biostatistics based on various supplementary materials such as courseware diskettes, a CD introduction to SAS and a set of web-based lectures.

2.TEACHING OUTLINES

I have taught biostatistics to undergraduate medical students as an optional topic and to graduate students as a compulsory requirement in their curriculum. In addition I have tried to broaden the scope of this course to attract students who have enough time to work on computer skills.

The main strategy of this course is to focus on statistical applications rather than on statistics itself. Therefore the students taking this biostatistics course are encouraged to apply the appropriate statistical concept to their own papers and to have frequent presentation and discussion during the semester. During these sessions all the students are brainstorming.

Course material

The text of this course is on video tape and delivered by cable television. There are two diskettes and a CD ROM which contains the contents of digital libraries on the w.w.w. as well.. With this courseware students can participate interactively as communication and feedback are an essential part of the learning process for many students. Students submit reports through e-mail and receive individual comments on the evaluation forms followed by a presentation in the next class.

Computer exercise

All chapters covered by this course have computer exercises using SAS or simple statistical software attached to the courseware diskette. All the results are presented and discussed in the class.

Presentation of proposals

In the graduate course by the 3rd quarter, all the students have prepared a proposal for their master doctorate thesis, covered research problems, outlined the purpose of their papers, identified their data collection methods and reviewed suitable statistical analysis methods. All the students have had the opportunity to apply statistical methods to various data sets in the health field.

Evaluation of the courses

This flexible course is offered in the nursing department at the master's level and at the medical college for undergraduates. With the aim of evaluating the course, a survey was taken from the University academic staff. Based on that data, we compared the attitude and performance of the students from ordinary courses and students following this flexible method.

The course syllabus

The following subjects were included in the courses schedule. The two final subjects were excluded in the undergraduate course and are as follows:

1. What is biostatistics;
2. Graphical and numerical summaries of data;

3. Point estimation and interval estimation;
4. Introduction of testing hypothesis;
5. One sample test and two sample test;
6. Categorical data analysis;
7. Midterm exam;
8. ANOVA;
9. Correlation and regression;
10. Presentation of proposals;
11. Non parametric statistics;
12. Multivariate analysis;
13. Survival analysis;
14. Final exam.

3. COMPUTER BASED SUPPLEMENTS

Nursing students working on their masters or doctorate degrees are strongly motivated to use statistics but do not have a strong mathematics or computer background. In contrast, the undergraduate students in their second year of medical college have little motivation and need for biostatistics but a strong motivation to use the computer. These student skills and attitudes suggested us to use the computer based supplementary materials described below.

3.1. COURSEWARE DISKETTE

In recent years there has been widespread expectation that the new generation of instructional computers will solve educational problems and help us to better achieve educational goals. For many educators, computer based education has become an instrument for modern education. Based on programmed instruction, courseware of statistics proves to be an effective media for learning concept principles and techniques. They were developed according to programmed instruction theory and compensated for the disadvantages of older computer devices and books.

Students received instructions from the computer using courseware and then responded to the computer individually. Using their individual pace of learning, the students achieved the fundamental statistical concepts. Computer Based Learning (CBL) resulted in high achievement with less time spent in school, thus increasing the interest in subjects like mathematics and statistics. Statistics particularly covers the data assessment methods, therefore high achievements in learning can be expected.

Statistics seems to be particularly suitable for illustrating the benefits of multimedia-based teaching. On the other hand, statistics connects quite different fields of application. This interdisciplinary character of the science can be well demonstrated by suitable videos and motivating examples closely related to medical data. Courseware of statistics could present an ideal platform for learning statistical concepts, and for discovering basic statistical principles by self-driven experiments.

The direct handling of computers results in a fundamental knowledge of computers for the students. This statistics courseware also contain a program for statistical package practice. The topics included in the courseware are as follows:

1. Basic descriptive statistics;

2. Probability and distributions;
3. Estimation and testing;
4. Correlation and regression;
5. Experimental design.

Each chapter has a self evaluative module through which students can check their performance and receive feedback for each item according to their results.

There was a final evaluation of CBL, and it was done by comparing the students' improvement in performance (experimental group) with a control group. Before and after the CBL coursework was completed, students in both groups were given a test on each chapter.

The improvement in performance between pre-test and post-test is shown in Table 1. The paired t-test based on Table 1, showed CBL was statistically significantly ($p<0.01$). There was also a statistically significant difference according to age and sex but no statistically significant difference by major ($p>0.05$).

Table 1. Performance for Computer Based Learning Experimental Group in Pre-test and Post-test

Variable	Group	Frequency (%)	Mean score in pre-test	Mean score in post-test
Age	Under 30	24(42.10)	52.14 ± 20.45	69.29 ± 28.14
	31-40	22(38.60)	55.00 ± 7.07	60.00 ± 4.14
	above 41	11(19.30)	40.08 ± 2.04	51.00 ± 6.50
Sex	Male	26(45.61)	46.00 ± 8.97	53.00 ± 7.51
	Female	31(54.39)	58.33 ± 7.22	80.35 ± 9.97
Major	Computer	34(59.65)	51.43 ± 9.95	65.71 ± 8.48
	Administration	23(40.35)	45.00 ± 7.07	49.00 ± 11.27
Total		57(100.0)	51.80 ± 8.80	64.70 ± 7.90

The effective index, derived by transforming the score into a standard score is 1.389. Thus the mean score of the results of the CBL schooling was located at a 138.9% when results without CBL are considered to be at 100%.

The correlation coefficient between pre-test and post-test is 0.783. This means that students who had better initial knowledge got a higher score in the post-test. The fitted regression line of the pre-test score and post-test score is $Y = 4.583 + 1.16X$. The statistical test of $\hat{\beta}_1 = 1$ in which there was no effect of CAI was statistically significant ($p>0.01$).

In the graduate class, the students had different ages and a range of mathematical and statistical background. This meant that they needed an individual learning method based on their prior knowledge, which can be easily provided with this kind of computer based learning program.

3.2. DIGITAL LIBRARY OF TV LECTURE FOR SAS ON THE WEB.

In Korea, the government encouraged collaboration among universities and the private sector, and the sharing of existing resources to provide web-based instruction to university students and adults. With the Korean government's support and funding, all

formal higher education institutions are now connected to the education and research network and have computer laboratories (Jung, Chai, & Chai, 1997). Many digital libraries have been established and linked. In 1998, the government started the Virtual University Trial Project in which 25% of higher education institutions in Korea and several private companies used advanced education for university students and working adults.

The Virtual University Trial Project has inspired about 25 percent of the formal higher education institutions and five private companies in Korea to collaborate in providing virtual courses using advanced technology and to explore the possibility of incorporating distance education into the computer-based system and even of establishing a distance technology in the near future. Interactive technologies seem to provide students with opportunities to receive learning support from the instructor. PC network and internet along with a telephone have been used as a formal channel for students to ask questions to their instructors and to interact with other students on the web, to have small group interaction among learners, and have access to a relevant information library (Jung, Chai, & Chai, 1999).

It is very important to note that KNOU (Korea National Open University) established a multimedia digital library system on the Web in 1997. This new initiative urged KNOU to digitise a TV, radio and audiocassette program. These digitised programs were integrated in a certain teaching and learning platform so that the students studied their course of SAS in a multimedia format on the web.

Now this digital library system is free of change to everybody. It can be said that we began to operate video-on-demand, not only for our students, but for the general public in Korea. It can be located at (http://kcsone.knou.ac.kr/frmstudy.htm). The information technology situation is getting better in Korea. In the near future every home will have access to the information superhighway. Therefore, the digital library system or Internet courseware is going to be more actively utilised by students. Multimedia software for statistics can go beyond closed instructional ms-word by offering properly maintained subject-specific gateways to recent statistical data and supplementary information from the rapidly growing internet. These elements are interactive and help the learner with activating simple moves and clicking in some documents.

There is a TV lecture demonstrating statistical analysis of data using SAS. Each chapter has a self-evaluation corner and Q&A corner. The digital library supplied above is operated through the world-wide web. The learning contents are laid down in HTML format. An internet browser gives access to the usual communication functions of a virtual educational network, for instance, to e-mail communication and course related lecture notes. Students with internet access are free to switch to a predefined point in the online course to download the latest lecture or additional information relating to the online lecture from the world-wide web.

Nowadays due to computer availability, there is much research and development done to provide a virtual class. The virtual class is defined as an institution that provides access to its educational services without the need for students to be physically present to receive them (Hiltz, 1995). A communication technology such as the internet system is needed as a main instruction and communication tool (Beur, Richards, & Lancaster, 1987). The motivation for a virtual statistics class is as follows:

1. Variety of educational demand;
2. Change of paradigm for statistical education;
3. Increase of access to the world wide web;

4. Enlargement of educational space;
5. Various levels of teaching-learning system.

The virtual statistics class started in universities in 1998. In establishing the trial project, the government sought to encourage partnerships among universities and the private sector and the sharing of existing resources (Cheng, Lehman, & Reynolds, 1991).

The limitation of web-based statistics education is as follows. From the instructors' point of view, it is difficult to express statistical equations on the web window, and to explain the process of proofs or extensions of equations. Consequently, a virtual statistics class would not be suitable as a graduate course for a statistics major. Also it was very difficult to quantify time needed for 1 credit of learning materials. On the students' side it is costly to access as an online course, and they feel a lack of interaction and personal touch (Hiltz, 1995).

Another survey was done for the evaluation of the overall effects of web-based instruction and to identify important factors to consider in designing effective web-based courses. The major results of the study were summarised as follows:

1. Compared with conventional courses which use textbook and broadcasting programs, web-based courses showed higher course completion and higher student performance. That is, about 75% of the students who took the web-based courses completed their courses and about 85% scored 80 or above out of 100.
2. It appeared that more than 70% of the students were satisfied with the various aspects of the web-based courses. Students showed a high level of satisfaction with the technical and instructional support from the instruction and the online assistants, course design strategies and active online discussion.
3. It was found that content design strategy was the most important factor affecting student satisfaction ($r=0.509$). In addition, students who studied web-based courses in a LAN environment showed more satisfaction than those in a modem environment ($p<0.05$).
4. In general, physical access to the environment, content design strategies and online activities seemed to be the most important factors affecting the effectiveness of web based instruction. One can also share a student's proposal.

5. REMARKS

All the students in the graduate course were interested in the computer based course material and resulted in good performances. They felt motivated by the course materials and expressed that they had a better understanding of reality, and the feedback through e-mail encouraged the students. Medical personnel enjoyed learning with various kinds of computer-based supplementary materials, and video lecture faced statistical challenges. With regard to the statistical issues related to their master's thesis, students were strongly motivated and worked very hard to successfully master the computer skills.

REFERENCES

Altman, D. G. (1991). *Practical statistics for medical research*. London: Chapman.
Altman, D. G.(1994). The scandal of poor medical research. *British Medical Journal,* 308, 283-

284.
Beur, G., Richards, H., & Lancaster, P. (1987). Attitude forward computers: Validation of a computer attitude scale. *Journal of Computing Research*, 31, 207-218.
Binyavanga, K. (1998). Statistics education in South African medical training institutions. In L. Pereira-Mendoza, L. Seu Kea, T. Wee Kee, & W. K. Wong (Eds.), *Proceedings of the Fifth International Conference on Teaching Statistics* (pp. 551-556). Singapore: International Association for Statistical Education and International Statistics Institute.
Cheng, H., Lehman, J., & Reynolds, A. (1991). What do we know about asynchronous group computer based distance learning? *Educational Technology*, 31, 16-19.
Svensson, E. (1998). Teaching biostatistics to clinical research groups. In L. Pereira-Mendoza, L. Seu Kea, T. Wee Kee, & W. K. Wong (Eds.), *Proceedings of the Fifth International Conference on Teaching Statistics*. (pp. 289-294). Singapore: International Association for Statistical Education and International Statistics Institute.
Hand, D. J. (1994). Deconstructing statistical questions. *Journal of the Royal Statistical Society Series A,* 157, 17-56.
Hand, D. J. (1996). Statistics and the theory of measurement. *Journal of the Royal Statistical Society Series A,* 159, 445-410.
Hiltz, S. R. (1995). *The virtual classroom*, Norwood, NJ: Ablex.
Johnson, D. W., Johnson, R. T., & Stanne, M. B. (1985). Effects of cooperative and individualistic goal structure on computer-assisted instruction. *Journal of Educational Psychology,* 77(6), 668-677.
Jung, I. S., Chai. S. W., & Chai. S. H. (1997). *Analysis of educational effectiveness using online network.* Seoul: Technical Report KNOU Institute.
Jung, I. S., Lee J. H., & Chai, J. K. (1999). An *evaluation study on the effects of web based instruction*. Seoul: Technical Report KNOU Institute.
Korea Biometric Society (1994). *Application of statistics in medicine and public health workshop.* Seoul: Korea Biometric Society.
Phillips, B., Francis, G., & Hutcheson, M. (1998). Statistics for workers in social and health sciences by flexible learning modes. In L. Pereira-Mendoza, L. Seu Kea, T. Wee Kee, & W. K. Wong (Eds.), *Proceedings of the Fifth International Conference on Teaching Statistics* (pp. 401-408). Singapore: International Association for Statistical Education and International Statistics Institute.

Tae Rim Lee,
Korea National Open University,
Department of Applied Statistics,
169 Dongsung dong, Jongro Ku,
Seoul 110-791 Korea.
E-mail: trlee@av9500.knou.ac.kr