Croatian Implementation of a Computer-based Teaching Program from the University of Kansas, USA

Marin Nola, Anamarija Morović[1], Snježana Dotlić[1], Mara Dominis, Stanko Jukić, Ivan Damjanov[2]

Department of Pathology, Zagreb University School of Medicine; [1]Department of Pathology, Zagreb University Hospital Center, Zagreb, Croatia, [2]Department of Pathology, The University of Kansas School of Medicine, Kansas City, Kan, USA

Aim   To determine whether the students enrolled in the computer-based teaching program would take the final examination in pathology earlier than those who studied according to the previous traditional program.

Methods   The study included all medical students enrolled in the pathology course at the Zagreb University School of Medicine, Zagreb, Croatia, between 1995/96 and 2000/01 academic years. In the fall of 1998, computer-based teaching program from the University of Kansas was implemented at the Zagreb University School of Medicine, with 48 of the class of 225 students (20%) randomly enrolled in the program. The remaining 80% of students of the same class were enrolled in the traditional teaching program used at the Zagreb University School of Medicine. We compared the success of these two groups of students at the final pathology examination in the first term. Following this initial observational period, all students in the next two years (1999/00 and 2000/01), were enrolled in the computer-based teaching program. Pass rates of these students at the final examination taken in the first term were compared with the pass rates of students who studied according to the traditional teaching program during the period from 1995 to 1998.

Results   In 1998, 58.3% of students from the computer-based teaching program group chose to take the final examination in the first term, compared with only 32.2% of students from the traditional teaching program group ($\chi^2_1 = 10.97$, $P < 0.001$). Students in the computer based program had better final examination mean scores ($\pm$ standard deviation) than students in the traditional program (81.9 ± 9.8 and 73.3 ± 14.2, respectively; $t = 2.908$, $P = 0.005$). Upon the implementation of the computer-based teaching program for the entire class in 1999 and 2000, the number of students taking the final examination in the first term increased more than we expected on the basis of the data from the academic years 1995 to 1998 ($\chi^2_5 = 39.60$, $P < 0.001$).

Conclusion   The computer-based program introduced at the Zagreb University School of Medicine in 1998 had a positive effect on medical students, as evidenced by the fact that more students chose to take the final pathology examination in the first term and more of them passed the examination in the first attempt than those in the traditional teaching program.

Students of the Zagreb University School of Medicine study pathology during the third year of their 6-year medical school curriculum. Traditionally, the pathology course was taught for two semesters every year and covered general pathol-ogy and systemic pathology. The course was based on a Croatian translation of an American textbook (1). The general pathology course covered the first eight chapters of the book and was taught during the first semester. The systemic pa-

thology course covered the remaining 15 chapters, taught during the last few weeks of the first semester and the whole second semester.

In 1998, the Department of Pathology at the Zagreb University School of Medicine obtained a grant from Open Society Croatia, a subsidiary of the Soros Foundation, to implement the transfer of teaching technology from the University of Kansas School of Medicine, Kansas City, Kansas, USA at the Zagreb University School of Medicine. As outlined previously (2), we used these funds to translate the computer-based teaching program developed at University of Kansas School of Medicine into Croatian (see cover page), and to purchase the software and hardware needed to develop a computer laboratory at the Department of Pathology at the Zagreb University School of Medicine. During the academic year 1998/1999, we introduced the computer-based teaching program and offered it to 20% (n = 48) of students taking the third year course in general and systemic pathology. This "experimental" group, called the computer-based teaching program group, was compared with the remaining 80% of the students (n = 177) in the class, who continued to study pathology according to the traditional teaching program already in use at the Zagreb University School of Medicine. Since the students' response to the new course was overwhelmingly positive and the preliminary data (2) promising, the Department of Pathology decided to offer the computer-based teaching program to all medical students enrolled in the course in the fall of 1999.

At the Zagreb University School of Medicine, medical students who have completed the pathology course requirements are allowed to take the final examination at any time during the official six terms, from June until October. Traditionally, the higher ranked or "better-prepared students" take the examination in the first term on June, whereas lower ranked, "less-prepared students", usually procrastinated and took the examination later, ie in the subsequent terms.

We hypothesized that the introduction of a computer-based teaching program would change the students' learning habits and compel them to work continuously during the entire school year. Furthermore, we assumed that students actively acquiring knowledge by participating in interactive seminars and discussion groups over a prolonged period of time, from October until June, would be better prepared for the final examination than students who participated in less demanding traditional teaching program seminars. Thus, we anticipated that during the introductory year, 20% of students in the computer-based teaching program group would do better than the rest of the class. We also expected to find differences between the students enrolled in the computer-based teaching program in 1999/00 and 2000/01 academic years and those in the traditional teaching program who studied in the period from 1995/96 until 1997/98.

Participants and Methods

This study encompassed all medical students entering the pathology class from 1995 until 2000, taking the final pathology examination at the Zagreb University School of Medicine from 1996-2001. During those six academic years, there were three distinct periods that differed with regard to the methods and approaches to teaching.

The first period included academic years 1995/96, 1996/97, and 1997/98, when all medical students were enrolled in the traditional pathology course.

The second period represented the transitional 1998/99 academic year, when a new course based on the computer-based teaching program developed at the University of Kansas School of Medicine was implemented at the Zagreb University School of Medicine. This course was initially offered to only three randomly selected groups of students comprising a total of 48 students, whereas the remaining 177 students continued to study according to the traditional teaching program. Although two different approaches to teaching were practiced at the same Department during the initial observation period from October 1998 till June 1999, there were several important similarities between the two programs:

1) Both programs covered the same teaching material (general and systemic pathology), and the students were required to study from the same textbook.

2) Seminar groups were of the same size in both the computer-based teaching program and the traditional teaching program. Each group comprised approximately 20 students.

3) The final examination was the same for both groups. It included a written multiple

choice examination, a practical part based on microscopic interpretation of histopathologic slides, and an oral examination.

4) Both groups of students were required to take the written examination in two parts, one given at midterm and the other at the end of the course. Six terms were assigned for the final written examination (from June 5 until October 15 of each calendar year) and the students could choose which term to take.

However, there were some significant differences between the two programs:

1) Until 1998, the pathology course at the Zagreb University School of Medicine had been based primarily on lectures and weekly 2-hour microscopy sessions combined with small group seminars. For students in the computer-based teaching program, the attendance of lectures was optional and the microscopy sessions were replaced by seminars utilizing computer stored pictorial teaching material.

2) The new program was accessible from personal computers (PC) and consisted of a) an outline (table of contents) which included a list of 40-50 color photographs with legends for each chapter, b) a list of key words with brief explanations, c) five representative clinical cases with questions for discussion, and d) review questions at the end of each chapter.

3) At the beginning of the course, we introduced an entrance pretest to test students' baseline knowledge, and during the course, we offered exams in various forms (midterm exam, monthly exams, and weekly quizzes) designed to monitor students' progress and to stimulate their continuous studying during the course. Weekly quizzes covered the material from the assigned reading for that week, usually a single chapter from the textbook, whereas the monthly examinations comprised the material from at least four chapters. The twenty-three weekly quizzes and six monthly exams were not mandatory, but students who passed these exams were awarded bonus points. Those bonus points were added to the total score achieved on the midterm exam at the end of first semester and the final exam at the end of second semester. The midterm and final examinations were mandatory.

The third period lasted for two years and included academic years 1999/00 and 2000/01.

After the completion of the pilot program in the 1998/99 academic year, the computer-based teaching program was applied to the entire class taking pathology in the 1999/00 and 2000/01 academic years.

We kept records of students' performance and compared the collected data on the percentage of students taking the final written examination in the first term during those years.

All data were statistically analyzed using the χ^2 test, and the significance of the differences was calculated as a P value. In all statistical analyses, only probabilities lower than 5% ($P<0.05$) were considered significant. Statistical analysis was performed with the Statistical Package for Social Sciences, version 12.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

During the 1995/96 academic year, a total of 250 students attended the traditional teaching program pathology course and 88 students (35.2%) passed the final written examination in the first term (Table 1). During the academic year 1996/97, there were 279 students enrolled in the traditional teaching program pathology course, and 64 (22.9%) of them successfully passed the final written examination in the first term. During the academic year 1997/98, there were 220 students attending the traditional teaching program pathology course and 76 students (34.5%) who passed the final written examination in the first term. These three groups of students did not differ from each other with regard to their pass rate on the first term final examination.

In the 1998/99 academic year, the class had 225 students, 85 (37.8%) of which chose to take the final written examination in the first term. Of the 48 students who were in the com-

Table 1. Total number of medical students and results on the final written pathology examination in the first term

Academic year	Type of program*	No. (%) of students		
		all	took the exam	passed the exam
1995/96	traditional	250	141 (56.4)	88 (35.2)
1996/97	traditional	279	112 (40.1)	64 (22.9)
1997/98	traditional	220	86 (39.1)	76 (34.5)
1998/99	traditional	177	57 (32.2)	39 (22.0)
	computer	48	28 (58.3)	23 (47.9)
1999/00	computer	243	135 (55.6)	133 (53.4)
2000/01	computer	219	160 (73.1)	136 (62.1)

*Traditional teaching program was based on lectures and weekly microscopy sessions; computer based teaching program offered optional lecture attendance, interactive computer based microscopy sessions, and midterm, monthly, and weekly exams.

puter-based teaching program, 28 (58.3%) chose to take the examination in the first term. Of the 177 students who were in the traditional teaching program, only 57 (32.2%) took the examination in the same term ($\chi^2_1 = 10.97$, $P < 0.001$). The final examination scores for the students who were in the computer-based teaching program ranged from 54-94% (mean ± standard deviation = 81.9 ± 9.8), and for the traditional teaching program group, it ranged 33-93% (mean ± standard deviation = 73.3 ± 14.2) ($t = 2.908$, $P = 0.005$).

Upon the implementation of the computer-based teaching program for the entire class in 1999 and 2000, the number of students (63.8%) taking the final examination in the first term increased more than we expected on the basis of the data from the academic years 1995 to 1998 (45.2%) ($\chi^2_5 = 39.60$, $P < 0.001$).

In the 1999/00 academic year, there were 243 students in the class taking pathology according to the computer-based teaching program. In that class, 133 out of 243 (53.4%) students passed the final written examination in the first term (only 2 students failed the exam). At the end of the next 2000/01 academic year, the results were even better: 136 out of 219 students (62.1%) passed the final written examination in the first term ($\chi^2_5 = 91.16$, $P < 0.001$).

Discussion

In the present study, we compared the performance of students at the Zagreb University School of Medicine who studied pathology according to a traditional lecture-based program with that of students enrolled in a computer-based active learning program. We compared the percentages of students from both groups choosing to take the final examination during the first term.

Objective evaluation was initially performed by choosing a subset of students as the experimental group. We enrolled them in the computer-based teaching program and then compared their results with the rest of the class that was in the traditional teaching program and served as a control group. The students in the computer-based teaching program were more inclined to take the midterm and final examination earlier than students in the standard program. Furthermore, the students in the computer-based teaching program had higher passing grades than students in the tra-

ditional teaching program. Thus, we concluded that the computer-based teaching program has had a positive effect on the experimental group and that next year we could offer the computer-based teaching program to the entire class. The introduction of the computer-based teaching program and the transfer of technology from the University of Kansas to the Zagreb University School of Medicine were briefly described in a previous paper (2).

The students' and professors' reactions to the "imported program" were evaluated subjectively. We observed a very positive reaction among students (through interviews and written evaluation of the course) and professors (interviews). The computer-based teaching program group accepted the program with great enthusiasm, whereas students in traditional teaching program group had an impression they were being left out. On the other hand, professors observed that students enrolled in computer-based teaching program group were more active, more interested, and more enthusiastic.

However, considering the small number of students in the "experimental" group, including only 48 students divided into three seminar groups, we wondered if the promising results of the program reflected just temporary reactions of the students, prompted by separating them from the rest of their classmates and by introducing a technologically advanced, computer-based teaching system in their medical education. Also, we were aware of the possibility that teachers coordinating the computer-based teaching program during the experimental phase of the program could be partially responsible for the good results their students achieved in the final exam. Thus, we performed the second part of the present study and we compared the results of the students who were in computer-based teaching program during the period from 1999/00 till 2000/01 with the performance of students enrolled in the traditional teaching program in the period before the computer program was initiated, ie from 1995/96 to 1997/98. Significant differences were again noticed, which confirmed the initial observations about the positive influences of the computer-based teaching program on students.

The beneficial effects of the computer-based teaching program cannot be explained on the basis of our data, but it is safe to conclude that they are by no means attributable only

to the new electronic technology. Several studies have shown that computer-based teaching in the clinical setting is not inferior or superior to classical preceptor based teaching (3,4). The novelty of the computers probably played a role in the initial period, but thereafter, the computers became commonplace and it is unlikely that the technology itself could have accounted for the students' success. Other aspects of the course probably also played a role and contributed to the success, but the contribution of these "intangible" factors, as noticed by others, is hard to evaluate (5,6).

Both students and professors noticed that the students were better prepared for the discussion groups that were computer-centered and required active problem solving skills. We presume that the students actually had to spend more time preparing for the computer-based seminars and probably read their textbook more carefully than their colleagues in the traditional teaching program. The fact that the computer-based material was clinically oriented and simulated real life clinical situations also probably contributed to the greater activity of the students who were in the computer-based teaching program. Others have also noticed that the students like computer-based clinical simulations (4).

Medical curricula are in a flux all over the world (7), and many new approaches are being tested (8). Many of these new programs include teaching based on computer-stored material and Internet (9,10). Although it is unlikely that an optimal and generally applicable system will be discovered, it is safe to predict that active-participatory learning will replace the previously passive, predominantly lecture-based approaches in most medical schools. Computers are obviously just one of the currently available teaching tools to stimulate active learning (11). If properly used, we believe that they can strongly motivate students to take an active role in their own education. Above all, computers may profoundly change students' attitude towards learning (6). Our results show that

such a change in the attitude may bear positive academic results.

References

1   Kumar V, Cotran RS, Robbins SL. Basic pathology. 5th ed. Philadelphia (PA): WB Saunders; 1992.

2   Dominis M, Nola M, Jukić S, Fishback J, Damjanov I. Computer-based teaching of pathology at the Zagreb University School of Medicine. Croat Med J. 1999;40: 425-8.

3   Vozenilek J, Huff JS, Reznek M, Gordon JA. See one, do one, teach one: advanced technology in medical education. Acad Emerg Med. 2004;11:1149-54.

4   Weller JM. Simulation in undergraduate medical education: bridging the gap between theory and practice. Med Educ. 2004;38:32-8.

5   Stromso HI, Grottum P, Hofgaard Lycke K. Changes in student approaches to learning with the introduction of computer-supported problem-based learning. Med Educ. 2004;38:390-8.

6   Issenberg SB, Scalese RJ. Multimedia computer-based measures of basic science and clinical skills. Med Educ. 2004;38:573-4.

7   Dušek T, Bates T. Analysis of European medical schools' teaching programs. Croat Med J. 2003;44: 26-31.

8   Šimunović VJ, Sonntag H-G, März R, Horsch A. Reform of medical education in Bosnia-Herzegovina: luxury or necessity? Croat Med J. 2004;45:31-7.

9   Peterson MW, Gordon J, Elliott S, Kreiter C. Computer-based testing: initial report of extensive use in a medical school curriculum. Teach Learn Med. 2004;16: 51-9.

10 Masic I, Kudumovic M, Novo A. Education of medical informatics at Medical Faculty of Sarajevo. Med Arh. 2004;58(1 Suppl 2):88-91.

11 Fenderson BA, Fenderson DA. Balancing traditional values in academic medicine with advances in science and technology. Croat Med J. 2004;45:259-63.

Correspondence to:
Marin Nola
Department of Pathology
Zagreb University Hospital Center
Kišpatićeva 12
10000 Zagreb, Croatia
marin.nola@zg.htnet.hr