Traditional Teaching Supported by Computer-Assisted Learning for Macroscopic Anatomy

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Over the years we have observed that there is a very low passing rate for the Anatomy and Neuroanatomy courses in our department, and for that reason we decided to implement the use of student-learning resources. The objective of this study was to compare the results of traditional methodology with those obtained with the support of computer-assisted learning (CAL). We performed a retrospective and joint study for Anatomy and Neuroanatomy groups during the period of September 2001 to February 2003, to establish a comparison between traditional learning and traditional learning supported by CAL. In the Anatomy group, students who used the traditional method (n1 = 365) received an average final grade of 58 (SD = 14.94), while the average final grade for students who used the traditional method supported by CAL (n2 = 283) was 68 (SD = 14.56). In the Neuroanatomy group, the students who used the traditional method (n3 = 217) had an average final grade of 61 (SD = 14.51), while the students who used the traditional method supported by CAL (n4 = 134) received an average final grade of 68 (SD = 13.52). A z-test was conducted to determine the difference in averages between the two groups (α = 0.05), and the results showed that the averages were significantly different (P < .001). The modified traditional method with CAL support was shown to be the best option in comparison with the traditional method. Anat Rec (Part B: New Anat) 278B:18–22, 2004. © 2004 Wiley-Liss, Inc.

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INTRODUCTION

This study discusses how we have taken our traditional teaching method and supported it with computer-assisted learning. Since the time of Aristotle, the study of the relationship between form and function, such as anatomy and physiology, has been considered a basic part of education in the health sciences (Paalman, 2000). For this reason, the subject of anatomy is indispensable in medical teaching.

Over the years, methods of teaching anatomy have gone through three stages, from simple observation to dissection of cadavers, and now to computer-assisted learning (CAL) (Trelease, 2002).

In 1910, Flexner introduced a medical education technique in which both basic and clinical sciences used the scientific method. In the 1980s this method was criticized for being too “horizontal” and “vertical” (that is to say, divided into independent compartments with no integration). It was also thought that students should not have access to patients if the students were not prepared in basic science (Marks and Cahill, 1988). With this method (termed the “traditional” method), the student attends conferences and the learning is passive. As a consequence, the use of the traditional method declined with the introduction of reform in the 1980s, which proposed that training in medical education must be integrated and patient-oriented (Marks and Cahill, 1988).

This reform introduced new techniques, such as problem-based learning (PBL) and small student groups to study cases, which were aided by “facilitators” who helped to integrate basic and clinical knowledge (Aziz et al., 2002). This modification considerably reduced the amount of time that students could dedicate to the study of certain subjects, including anatomy (Marks and Cahill, 1988), and some universities even abandoned the dissection of cadavers altogether (Aziz et al., 2002).

Education protocols for the first 2 years of medical school are changing, and over the past few years many schools have revised their curriculums or have started to debate how to modify them (Pabst and Rothkötter, 1997; Drake, 1998). New techniques and resources for teaching anatomy...
have been developed. For example, CAL is now used in human anatomy laboratories (Paalman, 2000). Additionally, different teaching techniques have been introduced, such as “brainstorming” (Geuna and Giacobini-Robecchi, 2002), animated presentations in Power Point (Carmichael and Pawlina, 2000), and educational videos (Galván et al., 1999). These new methods have yielded good results. In addition, three-dimensional software and multimedia computer programs for anatomy (Schwartz, 1980) have been developed for the same purpose (Trelease, 2002; Van Sint Jan et al., 2003).

In the past, our department has observed a very low passing rate for the Anatomy and Neuroanatomy courses, and for that reason we decided to implement the use of other resources for student learning. In this work we discuss how we have taken our traditional teaching methodology and supported it with CAL. We conducted a detailed study of the results obtained with the use of traditional methods only versus CAL-supported traditional teaching, which showed that learning improved with the latter method.

**METHODOLOGY**

A retrospective and joint study was carried out in which traditional (classical) learning was compared with traditional learning supported by CAL (hereafter referred to as “modified traditional”) in Anatomy and Neuroanatomy groups, from September 2001 through February 2003. The grades obtained by the students in these courses were considered as a dependent variable, and the method used (traditional or modified traditional) was an independent variable. We did not take into consideration demographic variables such as age, sex, or socioeconomic level, or psychological variables.

All of the students used an official textbook (Lockhart et al., 1965), and they were encouraged to consult a complementary atlas (Netter, 1997). In addition, for the past 4 years the department has updated a macroscopic anatomy compendium every semester, which includes clinical notes related to the content of the course. In the school’s bookstore, there is also a list of additional books for consultation (textbooks as well as anatomical atlases). The students have the option of purchasing these resources, and they rarely take advantage of this option because they would incur an additional expense, and the exams are based on the content of the official textbook. In addition to these supplementary materials, the department includes an area with a bone collection and an amphitheater, where students have access to materials such as bones, anatomical models, and cadavers.

When the students followed the traditional method (Fig. 1), the Anatomy group spend 91 h on theory and 60 h on dissection of cadavers. The Neuroanatomy groups spent 55 h on theory and 30 h on dissection of cadavers. For groups that used the modified traditional method, the theory and dissection classes were of the same duration, and a virtual classroom was used (Fig. 2). With this method, each student’s class attendance was registered on a credential that was given to the student at the beginning of the course. When the students finished their rotation, the frequency with which they had attended the classroom was counted and they were accordingly awarded points toward their final grade (Table 1). It must be mentioned that the students were only able to attend the classroom a maximum of
two times a week (2 h per week), due to student demand and physical space limitations.

The virtual classroom is a physical space located in the area of the Department of Human Anatomy. It has 24 personal computers that can be used by students to consult different programs, such as Power Point slides, a multimedia program (Fig. 3) created by the professors in the same department (Elizondo-Omaña et al., 2003), and various commercial interactive atlases.

Registered students in the Anatomy and Neuroanatomy courses were divided into two groups. One group was taught with the traditional method, and the other group was taught with the modified traditional method. The students’ average grades were obtained and then compared by means of a z-test at the end of the course for each subject.

**STATISTICAL EVALUATION OF TEACHING METHODS**

For the sample \( n_1 = 365 \) of the Anatomy groups using the traditional method, an average final grade of 58 (SD = 14.94) (Table 2) was obtained, with 24.93% \( (n = 91) \) passing. The average grade for students who passed the course was 77.96 (SD = 6.53). For the sample \( n_2 = 283 \) of the Anatomy groups that used the traditional method supported by CAL, an average final grade of 68 (SD = 14.56) (Table 2) was obtained, with 53.71% \( (n = 152) \) passing. The average grade for students who passed the course was 79.20 (SD = 6.40).

For the sample \( n_3 = 217 \) of the Neuroanatomy groups using the traditional method, an average final grade of 61 (SD = 14.51) (Table 3) was obtained, with 34.10% \( (n = 74) \) passing. The average grade for students who passed the course was 78.19 (SD = 14.51) (Table 3) was obtained, with 53.71% \( (n = 152) \) passing. The average grade for students who passed the course was 68 (SD = 14.56) (Table 2) was obtained, with 53.71% \( (n = 152) \) passing. The average grade for students who passed the course was 79.20 (SD = 6.40).

For the sample \( n_4 = 134 \) of the Neuroanatomy groups using the traditional method supported by CAL, an average final grade of 58.2% \( (n = 78) \) passing. The average grade of students who passed the course was 77.98 (SD = 6.61). A z-test was conducted to determine the difference between the average of the two groups \( (n = 0.05) \), which revealed that the averages of the groups were different \( (P < .001) \).

**DISCUSSION**

Changing the macroscopic anatomy curriculum is a challenging task, and it is necessary to evaluate educational methods to determine which are the most effective and efficient. In our study we observed a significant difference between the methods used in terms of average student grades. In agreement with our observation, Trelease (2002) concluded that the study of anatomy benefits from the incorporation of new methodologies based on computer and information sciences. However, since we did not compare the traditional and CAL-only methods in an isolated fashion, the current results must be interpreted with caution, as we believe that it is the combination of both techniques that produced the improvement.

Previous studies also obtained good results with the use of CAL in anatomy courses. For example, Carmichael and Pawlina (2000) noted that interactive resources, such as animated Power Point presentations, are excellent tools for teaching anatomy. Geuna and Giacobini-Robecchi (2002) concluded that brainstorming in anatomy courses can be a very efficient means of stimulating learning. According to Galván et al. (1999), the use of educational videos increases retention and long-term learning.

On the other hand, in a study in which each learning method was isolated, Bukowski (2002) found no statistically significant difference between groups of students who attended a theory class with cadaver dissection (completed traditional cadaver human gross anatomy course) and those who took a computerized self-directed course with no cadaver. Therefore, Bukowski (2002) suggested that technological resources do not provide a clear advantage. This is in contrast to the current study, in which CAL was used in combination with the traditional method. Previous studies by Plack (2000) and Peck and Benton (1970) indicated that CAL alone can be just as effective as the traditional method.

The results we obtained show, at least for our department, that a clear

![Figure 3. A multimedia program created by the professors in the department.](image-url)
advantage can be obtained with the modified traditional method. The change in the grade average observed with the use of the modified traditional method was directly influenced by the points awarded based on student attendance in the virtual classroom, but this increase was not sufficient to explain the difference observed in the group average. The results of our study suggest that an increase in the time dedicated to studying the subject, and the study method employed positively affected the achievement of students using CAL. The high rate of failure may be due to the absence of both; the combination (traditional method plus CAL) of both systems produced the difference in our study.

We do not know the exact cause of the high rate of failure by our students in Anatomy, but we believe that two factors may be the way the course is taught and the high difficulty of the exams (which have a morphological focus). Among other problems, we found that our students had not taken premedical courses, and we noted some demographical characteristics of the population (e.g., median age = 17 years) that may also be involved (Caplan et al., 1996; Forester et al., 2002). In addition, we believe that the number of hours a student spends studying a subject have a direct influence on achievement. We do not believe that a lack of trained teaching personnel is a factor, because the traditional class was taught by full-time professors, who were each assisted by two scholarship students.

According to other authors, multimedia resources are more widely accepted than the above-mentioned resources (such as bone collections and amphitheaters). The advantages of CAL include a more attractive presentation for students, the possibility of “surfing” the program according to one's needs, and interaction with the user. Given these advantages, we chose CAL as a resource to aid students in increasing their achievement scores in our department.

The students who used multimedia resources received the same information as those who did not use them. The difference in the results reflects the manner in which the information was presented, and, in our opinion, the CAL presentation was more attractive. The difference in achievement between groups is probably due to the fact that students who used multimedia resources were exposed to the study material for at least 20 additional hours during the semester.

We must mention that in our research, variables that could have some manner affected the results (such as age, sex, and socioeconomic condition) were not taken into consideration. It is known that certain student educational and psychological factors (such as emotional, intellectual, and personality aspects) can affect study results, as well as the educational level reached by the students. Therefore, further research must be conducted in which these demographic and psychological variables are taken into account to obtain more exact results.

Finally, we believe that if students would invest more time in areas such as the bone collection and amphitheater, they would probably achieve more, as was the case with the use of CAL. However, we cannot affirm that greater exposure to traditional materials (e.g., bone collections and anatomical models) would result in equal numbers of students passing the subject. For that reason, we recommend that a study be carried out comparing traditional learning enhanced by CAL vs. traditional learning enhanced by traditional resources (bone collections and anatomical models), using the same number of additional hours for both groups.

**LITERATURE CITED**


