STUDENT PERCEPTIONS AND LEARNING OUTCOMES OF COMPUTER-ASSISTED VERSUS TRADITIONAL INSTRUCTION IN PHYSIOLOGY

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This study compared student perceptions and learning outcomes of computer-assisted instruction against those of traditional didactic lectures. Components of Quantitative Circulatory Physiology (Biological Simulators) and Mechanical Properties of Active Muscle (Trinity Software) were used to teach regulation of tissue blood flow and muscle mechanics, respectively, in the course Medical Physiology. These topics were each taught, in part, by 1) standard didactic lectures, 2) computer-assisted lectures, and 3) computer laboratory assignment. Subjective evaluation was derived from a questionnaire assessing student opinions of the effectiveness of each method. Objective evaluation consisted of comparing scores on examination questions generated from each method. On a 1–10 scale, effectiveness ratings were higher (P < 0.0001) for the didactic lectures (7.7) compared with either computer-assisted lecture (3.8) or computer laboratory (4.2) methods. A follow-up discussion with representatives from the class indicated that students did not perceive computer instruction as being time effective. However, examination scores from computer laboratory questions (94.3%) were significantly higher compared with ones from either computer-assisted (89.9%; P < 0.025) or didactic (86.6%; P < 0.001) lectures. Thus computer laboratory instruction enhanced learning outcomes in medical physiology despite student perceptions to the contrary. AM. J. PHYSIOL. 273 (ADV. PHYSIOL. EDUC. 18): S55–S58, 1997.

Key words: computer-assisted instruction; computer laboratories

Computer-assisted instruction in life science education has been used in a variety of modes, including as an out-of-class study aid (3), a laboratory adjunct (4), and as a basis for generating information used in writing term papers (1). The common feature of these modes is that they are “outside” activities designed to augment didactic lectures.

Although procedures and software have been developed for using microcomputers to directly aid the delivery of a didactic lecture (2), there is very little information available on effectiveness of using computer simulations in a didactic lecture setting. To address this paucity, the present study compared student perceptions and learning outcomes of the following three modes of instruction: 1) standard didactic (i.e., traditional) lectures, 2) computer-assisted lectures, and 3) computer laboratory assignment.

METHODS

Components of the programs Quantitative Circulatory Physiology (QCP), from Biological Simulators, and Mechanical Properties of Active Muscle (MPAM), from Trinity Software, were used to teach portions of the regulation of tissue blood flow and muscle mechanics to a class of 92 students within the University of Kentucky’s Medical Physiology course during the
The author (D. Richardson) is the course director and teaches the circulatory and muscle sections.

The computer-assisted lectures consisted of using the QCP and MPAM programs as a lecture aid in the large class setting. In the computer laboratory assignments, students individually performed experiments using the QCP and MPAM programs in the College of Medicine computer laboratory, then wrote up the experiments as an out-of-class assignment. Material on the regulation of tissue blood flow and muscle mechanics that was not covered by computer-assisted lectures or laboratories was presented in a standard didactic "chalk talk" mode. To the extent possible similar topics or concepts of muscle mechanics and vascular control were covered by each of the three teaching methods. For example, basic concepts of muscle mechanics, such as length-tension relationship, force-velocity relationship, and force-power relationship, were distributed among the three methods. Topics related to the control of vascular smooth muscle tone, such as hormonal control of vasoconstriction and the myogenic mechanism, were similarly distributed among the three methods.

Subjective evaluation consisted of administering a questionnaire assessing what, in the students' opinion, was the effectiveness of each of the three methods of teaching used.

Objective evaluation consisted of comparing scores on questions generated from material covered by each of the teaching methods. The questions were presented within the framework of a 73-item multiple-choice examination covering six physiological topics, including muscle mechanics and tissue blood flow. Fifteen of the test items were relevant to the present study. These consisted of five test items each on material presented by each of the three methods of instruction being evaluated.

Subsequent to collecting the subjective and objective data, the investigator met with the student liaison committee to discuss the results.

An analysis of variance with repeated measures was used to analyze the data. In this model each student was compared with him or herself (i.e., repeatedly measured) across individual questionnaire or examination items. The F ratio was applied to all tests, and post hoc significance levels are given below.

**RESULTS**

Table 1 presents the results of the subjective evaluation by the students. Class means are shown below each scale. There were no significant differences between corresponding evaluation items in the Muscle Mechanics and Regulation of Tissue Blood Flow surveys. In both sets, the two computer methods received similar ranking. The computer rankings were significantly lower than the ranking given to the didactic lecture method (P < 0.0001).

Table 2 presents the results of the examination questions used for objective evaluation of the present study, five items each on the three methods of instruction. Scores based on questions dealing with material presented via computer laboratory assignment were significantly higher than those from either standard didactic (P < 0.001) or computer-assisted (P < 0.025) lectures. Combined scores from the computer lab and computer-assisted lecture questions were significantly higher than those from the didactic lectures (P < 0.004).

The second row in Table 2 gives the intercorrelation coefficients of each of the subtests to the examination as a whole without the subtest items. The coefficients were similar among the three subtest groups, and for each subgroup the relationship to the examination as a whole was significant (P < 0.05). This indicates that each subtest significantly contributed to total examination parameters such as discrimination and reliability.

**DISCUSSION**

Despite lowered perceptions of effectiveness, students scored significantly higher on objective examination questions based on material from computer laboratory assignments. Examination scores on test items from computer-assisted lectures were also higher compared with items from didactic lectures, albeit significant only when combined with computer lab test items.
On the surface, the present subjective and objective results seem inconsistent. However, a follow-up meeting with the student liaison committee revealed that the students’ connotation of “effective” dealt with time effectiveness as opposed to learning effectiveness. They felt that computer teaching, be it in the classroom or computer lab, was not time efficient compared with a traditional didactic lecture. Some of the liaison members felt that the computer lab was a better learning environment because students are more focused on the subject matter, a view that is consistent with present results (Table 2). However, due to time constraints of the medical curriculum, students seem to prefer the traditional didactic lecture because it is perceived as being a more time-effective method of presenting information.

From an instructional point of view, computer simulations in the lecture setting were found to be quite helpful in describing temporal events (e.g., the development of muscle tension during a single twitch). The fact that examination scores from computer-assisted lectures were slightly higher comparable to those from standard lectures (Table 2) suggested that the two methods are at the least equally effective in helping students learn the material. However, a drawback to the present experimental design is that this comparison was based on the presentation of similar but not the same material. In this context, identical material should be presented to separate classes by traditional and computer-assisted didactic lectures before definite conclusions can be drawn as to which method best helps students to learn. Regardless, the present students clearly did not perceive computer-assisted lectures as being an effective teaching method.

### Table 1

**Student perceptions (effectiveness scale)**

| Muscle Mechanics | 1) The effectiveness of teaching muscle mechanics by standard didactic lecture was: (not effective) 1 2 3 4 5 6 7 8 9 10 (effective)  | 7.7 |
|                 | 2) The effectiveness of teaching muscle mechanics by computer-assisted lecture was: (not effective) 1 2 3 4 5 6 7 8 9 10 (effective)  | 3.8 |
|                 | 3) The effectiveness of teaching muscle mechanics by computer laboratory was: (not effective) 1 2 3 4 5 6 7 8 9 10 (effective)  | 4.2 |
| Regulation of Tissue Blood Flow | 1) The effectiveness of teaching regulation of blood flow by standard didactic lecture was: (not effective) 1 2 3 4 5 6 7 8 9 10 (effective)  | 7.6 |
|                 | 2) The effectiveness of teaching regulation of blood flow by computer-assisted lecture was: (not effective) 1 2 3 4 5 6 7 8 9 10 (effective)  | 3.7 |
|                 | 3) The effectiveness of teaching regulation of blood flow by computer laboratory was: (not effective) 1 2 3 4 5 6 7 8 9 10 (effective)  | 4.3 |

Class means are shown below each scale.

### Table 2

**Learning outcome: results of objective questions on muscle mechanics and regulation of blood flow from standard lectures, computer-assisted lectures, and computer laboratories**

<table>
<thead>
<tr>
<th></th>
<th>Standard Didactic Lectures</th>
<th>Computer-Assisted Lecture</th>
<th>Computer Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class mean, %</td>
<td>86.6</td>
<td>89.8</td>
<td>94.3*</td>
</tr>
<tr>
<td>Intercorrelation coefficient</td>
<td>0.43</td>
<td>0.34</td>
<td>0.53</td>
</tr>
</tbody>
</table>

*Significant from didactic (P<0.001) and computer-assisted (P<0.025) lectures.
(Table 1). As indicated by input from the liaison committee, this view referred to time effectiveness as opposed to instructional effectiveness.

In summary, the present study compared student perceptions and learning outcomes of traditional didactic lectures, computer-assisted lectures, and computer laboratory assignments. The latter method was associated with significantly higher scores on objective questions. However, medical students did not perceive computer instruction as being effective because of time constraints. These results support the view that computer laboratory instruction could improve the teaching of medical physiology, but that increased emphasis should be placed on making computer instruction more time effective and more palatable to students.

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REFERENCES