Brief or New

The Effects of a Hypercard Tutorial on Student Learning of Biomechanics

William R. Croninger, John P. Tumiel, Thomas Sowa

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Students of anatomy and kinesiology frequently experience difficulty conceptualizing topics such as biomechanics, scapular humeral rhythm, and pathological alteration of the extensor mechanism by disease. These students often remark, “If I could just see it, I could understand.” This learning preference is theoretically supported by Gardner (1983) who postulated the existence of seven types of intelligence: linguistic, logical-mathematical, intrapersonal, spatial, musical, bodily kinesthetic, and interpersonal. Thornburg (1989) wrote that “our tendency is to teach to the linguistic, logical-mathematical, and intrapersonal learned, and to virtually ignore the other intelligences” (p. 45). A seemingly simple solution to this problem would be to augment didactic lectures with visual aids and animations that illustrate important concepts and content. Commercial visual aids, however, rarely are designed to match course sequences, text illustrations, or instructor preferences as to how material is presented and emphasized. Still pictures from overheads and slides do not allow for illustration of movement, a fundamental component of kinesiological courses. Traditionally created videotapes cannot visually integrate textural resources, schematics, anatomical drawings, and interactive repetitions of slow-motion illustrations without the use of expensive editing equipment.

Instructional technology (e.g. computers, laser discs, video imaging, and video display equipment) presents one possible avenue for assisting students in seeing biomechanical relationships. Instructor-designed, audiovisual text illustrations, meant to appeal to a student’s spatial intelligence, may integratively complement primary material presented through more traditional modes of instruction, such as the lecture.

Multimedia is the term frequently applied to computer software that has the capability to present information pictorially and auditorily, as well as textually. Kozma (1991) cited examples of successful use of multimedia in English composition and science courses and described KleinSmith’s efforts at the University of Michigan to augment lectures in biology with computer-based tutorials. These tutorials used multiple-choice questions that required students to combine information from the text and lectures to solve problems in biology. KleinSmith tracked student test scores over a 10-year period and reported a marked improvement of mean test scores after the introduction of the tutorials.

The purpose of the present study was to assess the effects of a computer-based tutorial on student understanding of biomechanical principles in occupational therapy. If found effective, the tutorial could allow kinesiology and anatomy instructors to augment classroom lectures. Students using such a multimedia tutorial would be able to access the information in a manner most suited to their individual styles.

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Method

Subjects
Forty occupational therapy students enrolled in a junior-level kinesiology course took part in the study. Students were alternately assigned to an experimental or a control group by matched or comparable grade point averages (20 students in each group). The groups were also matched for gender.

Instrument

Self-instruction modular tutorials were developed for use at two Apple Macintosh IleX{superscript}1 terminals with Apple Computer's Hypercard 2.2 software{superscript}2. Authoring software, such as Apple Computer's Hypercard, allows for instructor integration of text, still and moving video images, instructor-created animations, and integration of sound into a nonlinear presentation. Hypercard also allows for the creation of electronic 3-in. x 5-in. cards on which combinations of text, photographs, videoclips, and graphics may be placed. Cards then may be aligned in sequences, called stacks, which allow for logical development of concepts or theories. In addition, hot spots, or buttons, can be created on the cards. Buttons can be assigned functions such as stack navigation, display of high-resolution still photographs, or video images, and audio cues or messages.

The Hypercard interactive multimedia tutorial on biomechanics that was used in this study was the sixth stack developed under the Mac II grant that was jointly sponsored by the American Occupational Therapy Association and Apple Computer. Norman (as cited in Rheingold, 1990) has encouraged software authors to concentrate on knowing the task, understanding the learner, and structuring the program so that the learner remains the focus. In the initial five stacks that were developed, emphasis was placed on helping student users learn the Hypercard environment and defining the traits (competency with computer hardware and software and preferred styles of learning) of the average student user. Various stack designs and navigational techniques were evaluated during the creation of the initial five stacks. It was decided that the biomechanics stack used by students would have a tree structure. This structure greatly reduces the incidence of novice student users becoming confused inside the system (Gygi, 1990). Students are greeted by an initial page (the tree trunk) containing a brief explanation of the stack contents and upon which eight buttons are placed (see Figure 1).

Buttons provide the gateways to each of the stack's six topic threads (branches): force, vectors, torque, first-class levers, second-class levers, and third-class levers. Student users can move freely within each thread but must return to the initial card (trunk) to enter another thread. To further reduce confusion, all navigational buttons within threads have the same appearance and are in the same location on each card (Tognazzini, 1990) (see Figure 2).

The seventh button leads the student to a quiz that allows the student to test his or her knowledge of biomechanics. The quiz contains 11 multiple-choice questions. Students use the mouse to click on their answer choice, thus eliminating the necessity of mastering the keyboard (Crawford, 1990). Correct responses are immediately rewarded by an audio clip of applause; incorrect responses are followed by a "boo" sound. The importance of audio feedback in the completion of multimedia tasks has been documented (Chadwick, 1992). Each quiz card contains a button labeled help. Clicking on this button reveals a hidden area that gives the rationale for the correct answer (Sellen & Nicol, 1990) (see Figure 3). The eighth button allows the student to exit the program.

Procedure

Subjects of both the experimental and the control group attended lectures on biomechanics. In addition, subjects of the experimental group individually viewed the tutorial on biomechanics. The tutorial was self-paced and parallel content and materials presented in the lectures on biomechanics. In the quiz section of the tutorial, subjects of the experimental group were required to apply information gleaned from the tutorial to solve problems presented in a multiple-choice format. Their responses resulted in immediate feedback as to why an answer was correct or incorrect.

To lessen the influence of instructor bias, no changes were made to preexisting lecture notes, examination, or classroom procedures during the time of the study. All 40 students took an exam at the end of the 2-week teaching module that included 14 questions directly related to biomechanics.

Results

The mean exam score was 84 for the experimental group and 78 for the control group. Statistical evaluation (unpaired t test) yielded a probability of .056. When questions related to biomechanics alone were separately evaluated, the experimental group incorrectly answered an average of 2.5 questions, whereas the control group incorrectly answered an average of 4.5 questions. An unpaired t test of the mean number of incorrect answers was significant at the .01 level (p = .0063). The 6-point difference between the mean exam scores of the experimental and control groups approached but did not achieve statistical significance.

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1Manufactured by Apple Computer, 20525 Mariani Avenue, Cupertino, California 95014.
2Manufactured by Apple Computer, PO Box 898, Lakewood, New Jersey 08701-8989.
Welcome to this tutorial on Biomechanics. Feel free to move around in any fashion you like. Clicking over any box to the left will take you to sections on force, vectors or torque. The buttons on the right lead to information on various types of levers you will find in the human body. You can navigate within a section by using the arrows which appear at the bottom of each screen. A "return" arrow will send you back to this card. Some cards have a button labeled "clinical applications". Click on this to journey to an area where the clinical relevance of a topic will be explored.

Click over the "quiz" button on this card to try your knowledge out. Above all, enjoy!

Figure 1. Main menu.

Discussion

The positive effects of the interactive tutorial, as demonstrated by the results, suggest that the interactive computer-based tutorial may have had a positive effect on general student learning. This effect was specifically apparent in students’ responses to questions directly related to biomechanics, in which students in the experimental group performed significantly better than did students in the control group.

These results indicate that this method of augmenting teaching and learning is worthwhile, although the time dedicated to preparing and developing the Hypercard stack tutorial exceeded that which would have been invested in a more traditional tutorial approach. The advantages of computerized programming, such as random and repeat student access to tutorials, integrated visual aids, and application to future lectures with economy of preparation, more than make up for the initial efforts to construct the program.

Student reactions to the tutorial features of self-paced instruction, immediate multimedia feedback, and extended availability outside the classroom were overwhelmingly favorable. They requested that Hypercard stacks be created for lectures in kinesiology, anatomy, and neuroscience. The initial six tutorials (stacks), along with more recently developed software on goniometry, manual muscle testing, and kinesiological analysis, now run on a cluster of five Macintosh computers in one of the university’s computer laboratories.

Conclusion

Traditional lecture methods of instruction in anatomy and kinesiology often are limited in their ability to help occupational therapy students conceptualize complex biomechanical relationships. The purpose of this study was to determine the effects of computer-based multimedia tutorials on students’ learning of biomechanics. It was evident in this study that members of an experimental group receiving such multimedia, computer-based instruction performed significantly better than did a control group of their peers on test questions related to biomechanics. Although the tutorial approach resulted both in enhanced test performance and favorable student feed-
Torque is defined in the dictionary as a force which is capable of producing rotation. Here we will define torque as the product of a force and the moment arm (the length of the lever upon which it acts).

If the moment arm refers to the force attempting to produce motion we will call it the FORCE ARM. When it refers to the force resisting motion it is the RESISTANCE ARM.

Click over force and resistance for more information.

Figure 2. Example of biomechanics screen.

A muscle can produce the greatest force when it is:

a) near its normal resting length
b) nearly fully stretched
c) nearly fully shortened
d) doesn't matter. The force remains constant.

Figure 3. Example of test screen.
back, it warrants further study. Whether this approach can be generalized to other kinesiological and anatomical topic areas remains to be determined. In addition, the tutorial’s applicability to other academic settings and topic areas within occupational therapy should be considered.

References


