Fact Sheet

Evaluation of Computer Simulations (computational and realistic simulator models) to Teach Respiratory Mechanics and Gas Exchange.

Purpose of the Study

Drs. Jose Venegas and Tilo Winkler approached the Teaching and Learning Laboratory to conduct an evaluation of the two computer simulations in order provide feedback on how effective the two models were and suggestions for future design features of Simuvent.

Description of the Class/Lab

An essential area of lung physiology for medical and bioengineering students to understand is respiratory mechanics and gas exchange. The topics pose difficulties for students because of the abstract non-intuitive concepts that govern relationships between respiratory pressures, flows and volumes and gas exchange in spontaneous and mechanical ventilation. In addition, the learning task is made more difficult by the need for students to develop an appreciation of the clinical relevance of such abstract material. Drs. Venegas and Winkler incorporated into their teaching of respiratory biomechanics two computer simulations, a realistic simulator and a computational model, called Simuvent, to help students understand the complex, abstract content and appreciate better its clinical relevance. The realistic simulator creates a real-world situation in which students must work in teams to treat a patient (a simulator dummy) in respiratory failure. In contrast, the Simuvent, a computational computer model, addresses more complex sophisticated models of ventilation mechanics, gas exchange, and circulation to simulate in real time a patient in distress. Students manipulate parameters of mechanical ventilation to restore patient to safety.

Research Methods

Subjects: Subjects included students enrolled in Respiratory Pathophysiology (HST 100) and in Quantitative Physiology (6.022j/2.7927/BEH.371J/HST542J). The HST-100 students are working on combined degrees in medicine and engineering, while the large majority of quantitative physiology students, (83%) are engineering students.

Eighteen Quantitative Physiology students completed the Simuvent Evaluation Survey; 11 HST-100 students completed the Simuvent Evaluation Survey, and 37 HST-100 students completed the Simuvent/Realistic Simulator Questionnaire.

Methodology: Simuvent Evaluation Survey and Simuvent/Realistic Simulator Questionnaire were administered to the HST 100 students. Only the Simuvent Evaluation survey was
administered to the quantitative physiology students because they did have realistic simulator experience.

The three-page Simuvent Evaluation Survey includes seven-point rating scales, fill-in questions, and short answer questions. The one-page Simuvent/Realistic Simulator Questionnaire consists of six rating scale items in which students evaluate different aspects of the computer simulation, realistic simulator, and debriefing session. In addition, the questionnaire asks students to identify the one thing they would change about the simulator exercise.

**Results**

Students expressed that Simuvent only slightly enabled them to develop a more intuitive mental model of respiratory mechanics and gas exchange than if it had not been included in the class (4.17). However, they felt more strongly that Simuvent helped them to understand how to use a medical ventilator (4.66). They were less positive about how much Simuvent contributed to their comprehending lectures (3.55) and readings (3.28).

Students did report the use of higher order thinking during the Simuvent experience. They reported identifying relationships that govern respiratory and gas exchange (4.89) as well as manipulating parameters to in order to develop an intuitive feel for respiratory mechanics (4.90). They reported to a less degree visualizing respiratory mechanics (4.00), and making diagrams to understand relationships (3.89).

Students found the Simuvent experience to some degree challenging (4.65) and that it lead to new questions (4.88). While they did not find the experience excessively stressful (3.76), they indicated some frustration (4.65). Factors that lead to a positive learning experience were rated slightly above or below the mid value of "4": meaningful (4.20), enjoyable (4.04), stimulating (4.22), and motivating (4.15); exciting (3.50), rewarding (3.93), and moments of wonder (3.92).

Based on the results of the questionnaire regarding the three instructional methodologies (computer simulation, realistic simulator, and debriefing session), it appears the realistic simulator was the most effective. The difference in student rating of the realistic simulator and Simuvent is quite dramatic. Three areas in which the realistic simulator received high ratings (practical skills, motivation, and desire to work with simulation more), Simuvent received low ratings. Although, it must be pointed out that practical skills is not an area intended to be addressed by Simuvent. Moreover, in contrast to the realistic simulator, the Simuvent addressed conceptually more complex tasks. While the Simuvent shows promise in stimulating higher level thinking, student frustration with learning how to use the program hindered obtaining a clear picture of the actual effectiveness of the program.

Rudolph Mitchell 9/7/05