AN IMPROVED UNDERGRADUATE HUMAN FACTORS COURSE: THREE RESULTS*

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ABSTRACT

The undergraduate human factors course was improved at the Stevens Institute of Technology. The objectives of the course improvement were twofold: 1) to increase the quality of the course, and 2) to increase enrollment. Computer-based modules were developed and implemented to achieve these objectives. Three primary findings emerged from their use. First, students finished the course with a firm grounding in the empirical and experimental methods of human factors. Second, students generated more design solution alternatives by using the modules. Third, course enrollment increased by seventy-five percent.

INTRODUCTION

Under a Local Course Improvement Grant (SER-8001346) from the National Science Foundation, the undergraduate course in human factors at Stevens Institute of Technology was improved during 1980 through 1982. The first author served as the course instructor during these three years. The objectives of the improvement were to increase the quality of the course and to increase enrollment. Computer-based (CB) materials were developed, which students used to solve realistic human factors problems. The CB course replaced one based on lectures and a textbook (the LT course). Both objectives were realized, in that two qualitative gains were observed in the improved course, and enrollment doubled.

Lecture and Text Course

In 1980, the course was taught via lectures and texts (Lindsay and Norman, 1977; McCormick, 1976). Problem exercises were assigned, and students used the information from the lectures and texts to solve them. The 1980 course included no laboratory activity. Topics covered included anthropometry and biomechanics, vision, audition, cognition, motor skills, displays, controls, and performance evaluation. Students' grades in the LT course were based on their performance on the exercises and a final problem. For the final problem, students chose between three problems developed by the instructor, or incorporated human factors principles into their own senior design projects.

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** Work was done while at Stevens Institute of Technology

Computer-Based Course

In 1981 and 1982, CB modules were introduced. In 1981, anthropometry, biomechanics, tracking, and human information processing modules were introduced. In 1982, general human factors fluency, computer-person interaction, and display modules supplemented the three original modules. In these courses, computers were used in conjunction with lectures and a text for the problem exercises. Content information and methodology were conveyed primarily through the computer. These classes were given the same final problem assignment as the LT class.

Students in the CB courses improved their fundamental scientific and engineering skills and expanded their topic knowledge by using computer-simulated data. They were required to analyze and interpret these data to solve the problem exercises. In short, the CB courses fostered an increased sensitivity to and understanding of key human factors questions and modes of inquiry.

Evaluation of the Project

A formal evaluation of the improvement project compared student performance on the final problems across the 1980 (LT) and 1981 (CB) courses. Two graduate students in human factors assessed students' reports on the final projects. (See the project final report for details, Halstead-Nussloch, Detweiler, Jurkat, Hamilton, and Gold, 1983).

RESULTS OF THE IMPROVEMENT

The improvement produced many qualitative and quantitative gains, three of which are discussed in this report. The complete description of the evaluation study is covered in the project's final report. Before turning to these benefits, we should point out that the most notable costs incurred in achieving these gains centered on the the additional time and resources required to teach students to use the computer.

A More Realistic View of Human Factors

The first qualitative gain was that students left the improved CB course with a more realistic view of the scientific nature of human factors, and their abilities in that science. The course instructor and assistants observed this gain when grading the problem exercises.

Figure 1 shows how most students in the LT course approached solving the problem exercises. After identifying what was required to solve the problem from the instructor's statement of it, students looked at the text. Their search through the text appeared to be driven by their perception of the instructor's requirements, because they selected design features according to keywords in the instructor's statement. (A design feature is a variable or factor that can influence a design decision. For example, standing height influences door size.) Students then developed their design alternatives by choosing design features with the largest surface similarity to the requirements. One problem exercise that illustrates this point had students design a mail carrier's bag to "minimize fatigue." Over one-half of the class chose, as their only design, a pack with both a front and rear pouch. This choice was clearly inspired by McCormick's text (1976--Figure 7-9, pg. 174), which shows that a double (front and back) pack minimizes oxygen consumption, when contrasted with six other options. Many who chose it went to great length to compensate for difficulties associated with the front and back pouch. Only a few students attempted to determine if oxygen-consumption differences between the double pack and simpler designs would

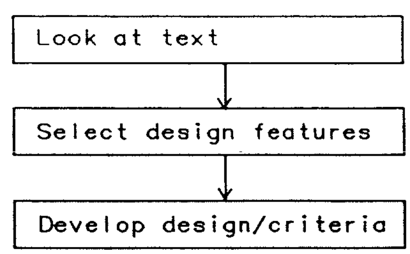

Figure 1: Problem solving approach in lecture and text course

have a significantly negative impact to warrant choosing the more complex design. This case, along with others, led us to the conjecture that students in the LT course searched for "answers" in the text, and engaged in little of the scientific inquiry required for quality human factors engineering.

Figure 2 shows how most students in the CB courses approached solving the problem exercises. The essential difference between the CB and LT processes is that the CB process requires the student to run a simulated study to assess and decide which of the potential design features to incorporate into the design. Before developing the design, the student is responsible for understanding the studies that can be simulated, posing important questions to guide the study designs, running the simulated studies, and deciding whether the data are adequate to answer the questions. This was witnessed when students in the CB course designed a video game whose levels of difficulty were predicated on target visibility. As such, students relied on computer simulations of visual acuity and tracking. This entailed interpreting simulated data and making design decisions about illumination, visual clutter, target size, and other salient variables.

We observed that students in the CB course developed a healthy respect for data and the importance of rigor in human factors, because they confronted and resolved problems that could only be solved by determining, for themselves, the human factors implications of (simulated) data. Because the LT course could not provide a comparable problem-solving experience, the improved course gave the students a better and more realistic understanding of human factors.

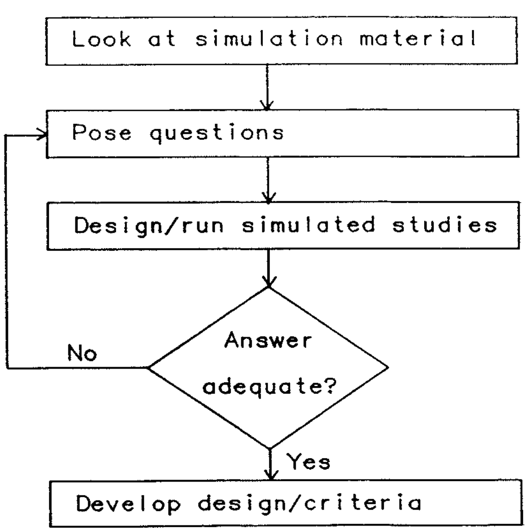

Figure 2: Problem solving approach in computer-based course

Increased Numbers of Human Factors Solutions

The second qualitative gain derived from the improved course was that its active-problem-solving approach fostered increased numbers of viable solutions to human factors problems. This finding was obtained in the evaluation study. It applies to the final projects completed under the option of a human factors analysis of the senior design project. This was the only open-ended option for the final project. Figure 3 illustrates that both coders found LT students produced only one solution; whereas, the CB students tended to generate multiple numbers of viable human factors solutions. (Inter-coder reliability was 0.69. 1980 N was 20, and N for 1981 was 17. Between-year differences were significant at the 0.05 level for both coders, coder 1's t was 2.5, and coder 2's t was 2.0.)

As Meister (1982) indicates, so many factors and forces are competing with human factors in engineering design that chances of human factors considerations surviving through the total design process increase in relation to the number of design alternatives manifesting viable human factors principles. In short, the improved course increased the chance that

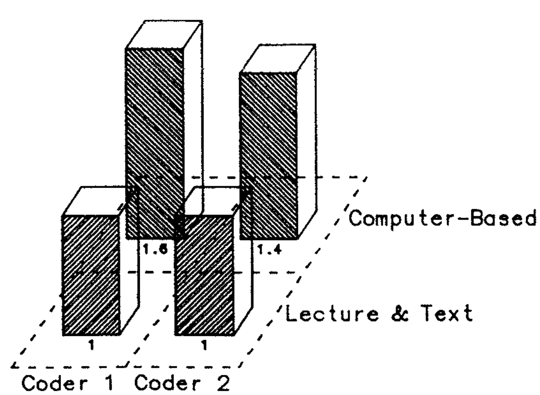

Figure 3: Number of viable human factors solutions generated

human factors would be incorporated in design by increasing the number of alternatives generated with good human factors.

Increased Course Enrollment

Enrollment in the CB course increased by seventy-five percent over that of the LT course. Figure 4 illustrates this increase over the period of the improvement project. The evaluation showed quality did not decrease in any area. No increase in instructional personnel was required.

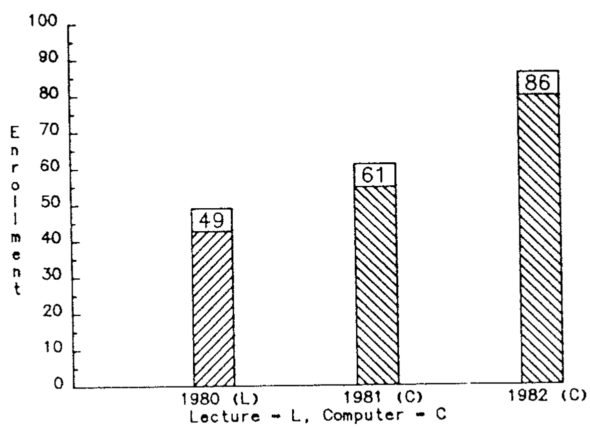

Figure 4: Course enrollment over three years of the project

CONCLUSION

With a few exceptions, most human factors knowledge is not popularly characterized as being rigorously scientific or representative of sound engineering. Many engineers and people claim authority as human factors specialists merely because they are human. Indeed, engineering students in the LT course openly questioned whether much of the text gave them increased value over their "common sense." To change this misconception, one must demonstrate scientific rigor and sound engineering in human factors. The CB course represents a step in this direction.

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