TEACHING SOFTWARE PSYCHOLOGY EXPERIMENTATION THROUGH TEAM PROJECTS

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INTRODUCTION

This paper describes an undergraduate human factors course which emphasizes psychologically oriented experimentation on the human use of computers. The reductionist principles of the scientific method are emphasized throughout the course: lucid statement of testable hypotheses, alteration of independent variables, measurement of dependent variables, selection and assignment of subjects, control for biasing, and statistical testing. Term-length team projects are highly motivating for students and have led to worthwhile research contributions.

The software psychology or human factors approach is increasingly important since the intuitions of experienced computer professionals are no longer adequate to guide designers of software standards or interactive systems. Scientific study of human performance in programming is necessary when software is a central component of life-critical systems such as intensive care units, air traffic or nuclear reactor control, police or fire dispatching, and spacecraft guidance.

Further motivation comes from the expanded use of computers by non-technically trained people in office automation or personal computing applications. Controlled experimentation can lead to valuable insights about the components of user friendliness: ease in learning, speed of performance, error rates, retention, and subjective satisfaction.

COURSE OVERVIEW

The central difference, in my view, between a human factors and other computer/information science courses is the emphasis on controlled psychologically oriented experimentation on human subjects. Computer science or information systems majors often encounter questions of experimental design and statistical analysis for the first time when taking a course on human factors in programming or user interface design. Since it is unrealistic to teach a complete course in experimental methods, I try to convey only what they need to comprehend some of the research literature and to carry out their own experimental projects.

This novelty in course content mirrors the new approaches that researchers in human factors of computer and information systems must learn. The traditional computer science approach of introspection, mathematical analysis, and theorem proving is now being enhanced by rigorous controlled experimental testing and construction of cognitive models of human behavior. This rich blend provides fresh insights and a clearer understanding of how to design better user interfaces, programming languages, software development methodologies, and database query facilities.

Teaching students these experimental approaches by experience has been challenging and rewarding. Within a typical 15-week university level course students may be required to design, administer, evaluate and write up a complete experiment. I have found this laboratory approach extremely productive in that it makes the issues more realistic and is highly motivating for students. Since the students may not be experienced in experimental design, precise guidance is essential to ensure success.

I encourage students to work in teams of two, ideally composed of a computer/information science oriented and a psychology oriented major. Having a partner is useful to split the workload and increase the diversity of skills within a team. I allow students to choose their partners and do allow one-person or three-person teams.

The teams make their experimental proposals and I provide feedback for revisions. Then the experimental materials are submitted for review and revision. Next a pilot study with 3-15 subjects is required to test out the experimental materials and to gauge the difficulty of the task for the intended subjects. Students and professional researchers are notoriously bad in judging how long it will take subjects to perform a task or how difficult they will find it. A report on the pilot study describing what happened and what changes have been made is required.

Administering the experiment turns out to be a great moment in the course. I encourage students to make contact with instructors of courses which have students with the right background to be subjects. If necessary I will contact the instructor to answer questions, but generally instructors and students are intrigued by the novelty of being involved in an experiment. Instructors should be shown the experimental materials and told how much time is needed when they are asked to permit use of their course. We have found that fixed-time experiments work best, but subjects should be told that they must stay till the end of the experiment. We have our subjects sign an experimental consent form in which they affirm their voluntary participation and their right to quit at any time. Student subjects are usually interested in the experiment, but can become unhappy if the task is completely unrelated to their course work, extremely difficult or extremely time-consuming. Many student-run experiments are completed in 15 or 20 minutes but others have taken 45 minutes or an hour. When the experiment is administered the team members should be present to answer questions and demonstrate the importance of the research effort. In about ten percent of our experiments something went wrong during the administration which required a new set of subjects and a new administration.

REPORT FORMAT

Project teams should turn in their experimental data in compact form and conduct their statistical analyses by hand or with available statistical program packages. The format for the final report is (the figures in parentheses indicated estimated length in double-spaced typewritten pages):

1. Introduction (3-6)
   State the area of research and why it is interesting.
   Describe relevant previous research.

2. Experimental procedures (1-2)
   State the hypotheses and briefly outline the experiment. Briefly describe the pilot study.

   2.1 Subjects (1): Describe subjects, their background and assignment to experimental groups.

   2.2 Materials (1-2): Describe the materials so that the knowledgeable reader has a clear picture of what they were like.

   2.3 Administration (1-2): Describe the test conditions, time, protection of anonymity.

3. Results (2-3): Uninterpreted results with tables, graphs, histograms, etc. This is a simple report of what happened.

4. Discussion (3-6): Explanations, conjectures, interpretations, and suggestions for future experiments. Advice to practitioners and researchers.

5. Conclusions (1): Summary and statement of most important findings.

6. References.

7. Appendix: Complete set of experimental materials.

I require a first draft of sections 1 and 2 of the final writeup to be turned in early for review and evaluation. When the final reports are turned in, students make 5-10 minute presentations about their findings. Several student projects have led to a published results or have been combined with other work to form a publishable paper. In other situations student projects have become the basis for larger experiments. In any case, the goal for the students is merely to gain experience with experimentation.

SCHEDULE

I've found it important to have numerous milestones to structure the student's work. Late submission of these intermediate stage materials is discouraged but accepted. No grades are given for these submissions. I've used the following schedule:

2nd week - brief description of topic area and team member names

3rd week - statement of the hypothesis, independent and dependent variables, experimental design and background of subjects

5th week - first draft of experimental materials for review and identification of subjects to be used (contact should have been made with the course instructor or the manager if professional subjects are used)

7th week - one page description of pilot experiment and intended revisions

9th week - sample of statistical reports from hypothetical data (familiarizes students with statistical techniques and software packages such as SPSS or SAS)

10th week - after actual administration, submit raw data in compact form

11th week - first draft of sections 1 and 2 of final report

12th week - tables, graphs or histograms of results

14th week - final report and class presentations

Directing a large number of student experiments can be time-consuming for the instructor, but it is exciting and rewarding. The students generally have very positive comments about this component of the course work. They can genuinely be pursuing state of the art questions and often become intensely involved in their projects. Several students have pursued their experiments in succeeding terms as independent study projects.

SUMMARY

Undergraduate students can be motivated to learn about software psychology issues quite effectively by requiring a term length team project. Difficulties may arise and more than average amounts of instructor effort are required but the rewards for the students and the instructor can be great.

It is gratifying that this course has been received with tremendous student interest. For the Spring 1982 semester 157 students attempted to pre-register for the 35 seats. Training undergraduates in the software psychology approach can have a strong impact on the professional workplace in the coming years, but only if sufficient numbers of universities institute similar courses. I look forward to the expansion of course offerings on human factors issues and to the inclusion of these topics in the undergraduate computer/information science curriculum.

We must begin to train the next generation of professionals to be more aware of the importance of human performance aspects in software development and interactive systems design. Simultaneously, we must nurture a greater sensitivity and desire to serve the needs of programmers and interactive systems' users.

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