5. INSTRUCTIONAL SOFTWARE

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A review of Macintosh-based instructional software

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This paper reviews Macintosh-based instructional software. The programs that are discussed can be used as laboratory exercises for data collection and data analysis, or for computer-assisted instruction. Some suggestions for state-of-the-art software in each of these categories are made along with some comments regarding instructional objectives for each set of programs.

Instructional software has changed significantly since the early 1980s when computer-based laboratories were first introduced (Goolkasian, 1985). We have recently upgraded our undergraduate computer laboratory by installing an AppleTalk network with Macintosh IIsi computers and have some suggestions for state-of-the-art instructional software. This review follows in the tradition of Hornby and Anderson (1990) and Butler and Neudecker (1989) by providing some comparative data and, also, updates previous work with a state-of-the-art library of programs for psychology instruction.

The programs are compatible with System 7, and run effectively on a Macintosh with a coprocessor, at least 5 MB of memory and an 80-MB hard drive. The laboratory functions as a student center for data collection and data analysis, and each piece of software was chosen to meet specific instructional goals. Although the laboratory was developed primarily for students enrolled in Research Methods in Psychology, it is also used for demonstrations in upper division courses (i.e., Sensation and Perception, Physiological Psychology, and Human Cognitive Processes) and by students enrolled in independent research. Table 1 lists suggested software in each of three categories.

Laboratory Exercises

The programs in the first category provide the means by which students can gain "hands-on" experience in data

collection with a wide variety of experimental procedures. Although all of the programs in this category are used for data collection, they differ in the extent to which a laboratory procedure can be modified. Some provide ready-to-run exercises (i.e., Experiments in Cognitive Psychology) that follow a contemporary paradigm from the psychological literature while others (i.e., SuperLab) are tool-based and require the user to set up a customized experiment by using a series of interactive menus. The ease with which the software can be modified to customize the laboratory procedure can be an important variable when one is trying to meet specific instructional objectives. For example, ready-to-run programs are useful for providing students with a data-gathering experience in a specific area or with a specific research design. Experiments in Cognitive Psychology, for example, demonstrate a variety of cognitive phenomena with repeated measures designs. Research methods and statistical skills relevant to these designs can be trained through data collection and data analysis exercises that use this software. However, if an instructor wishes the students to go beyond this stage and to become involved in critical thinking exercises, then tool-based programs that are flexible and allow students who are not proficient programmers to design their own research projects can be useful. Generally, these exercises require students to read about psychological phenomena, critically evaluate contemporary explanations, and then develop their own hypotheses for laboratory testing. Specific comments regarding the instructional impact of each of the recommended pieces of software are as follows.

MacLaboratory is probably the most versatile of the programs listed. It provides ready-to-run procedures for data collection as well as a set of tool-based features for customized experiments. It is the second version of an award-winning program. (Both versions of the program

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Table 1
A Software Library for Instruction in Psychology

Name	Version	Cost	Vendor
Lab Exercises			
Experiments in Cognitive Psychology		\$400.00	Stanford University Office of Technical Licensing, 857 Serra St., Stanford, CA 94305 (415) 723-0651
MacLaboratory	2.0	\$189.90	MacLaboratory, Inc., 314 Exeter Rd., Devon, PA 19333 (215) 688-3114
SuperLab	1.4	\$375.00	Cedrus Corp., 11160 Veirol Mill Rd., L-15, 221 Wheaton, MD 20902 (800) 233-7871
T-Scope	1.4 bl	\$20.00	Department of Psychology, Reed College, Portland, OR 97202
Data Analysis			
SYSTAT	5.2	\$795.00	SYSTAT Inc., 1800 Sherman Ave., Evanston, IL 60201 (708) 864-5670
SuperANOVA	1.11	\$321.75	Abacus Concepts, Inc., 1984 Bonita, Berkeley, CA 94704 (800) 666-7828
DataSim	1.0	\$65.00	Department of Psychology, Bates College, Lewiston, ME 04240
Computer-Assisted Instruction			
BrainStacks		Free with textbook adoption	Harcourt, Brace & Jovanovich 755J Caldwell Ave., Chicago, IL 60648 (800) 237-2665
Active Eye		\$99.00	Lawrence Erlbaum Associates, 365 Broadway, Hillsdale, NJ 07642-1487 (201) 666-4110
Eye Lines	1.0	\$99.00	Department of Psychology, Alma College, Alma, MI 48801
HyperCard Development Kit		\$110.00	Apple Computer Co.

have won the EDUCOM/NCRIPTAL educational software award.) The program, written in HyperCard, consists of modules built around such specific laboratory exercises as reaction time, problem solving, motor skills, and hemispheres. After an experiment has been constructed, it can be saved and used to run subjects through a sequence of trials. MacLaboratory also permits more advanced applications for those who are familiar with HyperCard. It is possible, for example, to use the reaction time module to create a customized experiment in which reaction times are recorded with millisecond accuracy.

This program was used most often for data collection exercises in Research Methods Lab. It offered easy-to-use lab exercises that permitted some control over experimental conditions. It is particularly versatile in demonstrating types of designs. The programs could be used to provide experience with both between and within research designs and offered considerable flexibility in the complexity of the design. Choice of the number of levels

of a variable to be tested as well as the number of variables to be manipulated can be determined by the user.

Experiments in Cognitive Psychology is a set of 21 ready-to-run laboratory exercises in attention, memory, and thinking. Like MacLaboratory, the program won the EDUCOM/NCRIPTAL educational software award, and it consists of HyperCard stacks. Each exercise is a self-contained experiment that includes everything from the instructions and practice trials to a set of references and figures for displaying the data. The exercises are rigid, however, in that they do not permit modifications and they are limited to repeated measures designs involving from one to three factors.

Unexpectedly, there were several bugs in the software that was provided by the vendor. So, even though these exercises did an excellent job of reproducing the original laboratory procedure and provided a comprehensive instructional module, we needed to debug many of the exercises. Converting the programs with HyperCard 2.0 solved part of the problem, and others were merely instances in which

a line of code was entered incorrectly or was missing. None of the problems were serious, however, and they could be fixed by someone knowledgeable about HyperCard.

The other programs in this category are completely tool based. SuperLab 1.4 is useful for studies in which PICT files are displayed and reaction time or accuracy is recorded. The advantage of this program lies in its precision: data are collected with millisecond accuracy. Also, SuperLab provides instant switching and refresh line synchronization to minimize any problems in presenting visual stimuli on a computer monitor. With some minimal instructions from instructors, SuperLab can be very useful for independent research projects. Students find this program easy to use and quite efficient for data collection. This program can be recommended as an excellent tool for programming an experiment in perception, memory, or cognition. Although it has some weaknesses (it has no randomization procedure and does not read text files), the limitations have not been difficult to work around. Data files created in SuperLab can be easily imported into a data analysis program.

TScope (Doenias, Langland, & Reisberg, 1992) is another tool-based program that allows the user to construct a customized experiment. As with SuperLab, stimulus presentations and reaction time responses are precisely timed. Text files are used for the stimulus, and the program can be recommended for verbal learning or memory experiments.

Data Analysis

As a group, the data analysis programs are a more sophisticated product than the earlier programs written for the first generation of microcomputers (Butler & Jones, 1987). They are powerful, integrated programs with graphical capabilities. Marchak and Zulager (1992) have reviewed the ease of use of the visualization tools that are available in some of these programs. Since there are already comprehensive reviews of the data analysis programs that are available for the Macintosh (Best & Morganstein, 1991; Lehman, 1986), this review focuses on the programs that are especially useful in instruction.

For data analysis in our research methods course, we use SYSTAT. It provides a comprehensive list of statistical tests, and it permits data entry in a spreadsheet format with editing capabilities. When compared with popular mainframe programs (SAS and SPSS), SYSTAT is comparable in power but is easier to use and has more advanced graphics. Of all the programs in our library, this was the one used most frequently by both faculty and students. Student evaluations indicated that 68% of the students thought that SYSTAT made it easier to learn the course material, and 80% disagreed that the program was useless for their understanding of the course. The percentage of students indicating ease of learning the material was slightly up from the previous semester, when much more limited Apple II statistical programs were in use.

However, even though it was rated highly by the students, there were a number of complaints about difficulty. The percentage of students who experienced some frustra-

tion with SYSTAT was higher than in previous semesters when Apple II statistics programs were used. The percentages are, respectively, 35 and 20. SYSTAT was not as intuitive or user-friendly as other Macintosh programs. The students needed to refer to handouts for computing most of the statistical tests. The program had a tendency to overpower those just beginning to learn about data analysis. We are working to reduce the frustration factor by developing 1-page handouts that guide the student through a statistical procedure. Although extensive manuals accompany this software program, we needed to develop handouts more tailored to the limited sets of statistical procedures that are used in undergraduate courses. Preliminary student reactions from this semester indicated that the handouts were effective in reducing some of the frustration that the first group of students experienced with the program. After some initial instruction, however, the students became quite proficient with this software and were quite independent in their applications.

SuperANOVA is the recommended package for the analysis of variance. Compared with SYSTAT, SuperANOVA does not provide as comprehensive a set of statistical tests, but it is reported to be more intuitive and user-friendly than the other. As with SYSTAT, the data are entered in a spreadsheet format and the graphics are effective.

DataSim (Bradley, Senko, & Stewart, 1990) is also recommended as a general-purpose statistical package for univariate data analysis. This package differs from the two previous programs because it is designed to conduct sampling experiments and will generate simulated data. The data simulation capability has some distinct advantages for instructional demonstrations and for student exercises in sampling theory. Users find this program to be relatively intuitive and user-friendly.

These programs were chosen over others specifically designed for student use (e.g., StatView, MYSTAT) because we wanted a data analysis experience that would build research skills. To provide the prerequisite experiences for research in psychology, students need to be exposed to state-of-the-art data analysis techniques. Our experience suggests that students can become quite proficient and versatile with SYSTAT after some practice, as long as the exposure is gradual and handouts are provided for some of the basic procedures. For example, it is important to teach data entry and descriptive statistics before involving the students with ANOVA and more complex procedures. The primary advantage of these programs is that students receive experience with programs that teach data analysis skills that will readily translate to their performance in more advanced courses and research experiences.

Computer-Assisted Instruction

The last category includes programs that can be used by students for repeated practice with conceptually difficult material, or provide animated demonstrations of perceptual or physiological phenomena. These programs involve extensive use of graphics and animated displays, and they are interactive in such a way that the students direct the search through the stack rather than turn elec-

tronic pages as sometimes went on with earlier versions of computer-assisted instruction (CAI) software.

The Active Eye Stack is a HyperCard database that contains over 50 dynamic classroom demonstrations of motion perception phenomena. Displays of biological motion, apparent motion, and frames of reference are useful supplements to lectures in sensation and perception. These programs can also be used as tutorials, since each demonstration is accompanied by a synopsis card that describes the phenomenon and directs the user to references.

Eye Lines (Beagley, 1991) was placed in this category because it has some nice demonstrations of the classic illusions, such as Müller-Lyer, Zöllner, and Delboeuf. However, it was developed as a tool-based program for customized experiments with line drawings. It could have fit easily into the first category of software.

BrainStack is a HyperCard application that focuses on the human brain and on the way in which the cortex controls human behavior. Text and graphics are mixed in a highly interactive way to allow students to find out about brain structure and function. This program can be valuable as a tutorial for students enrolled in physiological psychology. Students often have difficulty in attempting to conceptualize brain functions, and the nice mix of text and graphics may be beneficial to students who have difficulty with the textbook.

HyperCard comes with the Macintosh, and it is useful for developing customized programs in psychology because of the ease with which text and graphics can be combined. We have used it to develop several exercises—a CAI module that provides extensive practice with interactions from a factorial design (modeled on a popular Apple II program “interactions”), a correlational exercise that involves the administration and scoring of two anxiety inventories, and a reliability exercise. Although HyperCard is provided with each computer, the development kit includes a more elaborate version of the program and some manuals for developing stacks.

Conclusions

Because of their versatility, the programs in Table 1 are better than the programs that constituted the first generation of microcomputer programs. They can be used as tools for both research and instruction. Students gain experience with state-of-the-art materials rather than watered down programs that are merely classroom exercises. The emphasis on user friendliness that dominated our discussions 10 years ago has been softened, and we are realizing that students sometimes have to experience some frustration in order to learn research skills.

To evaluate whether our laboratory upgrade influenced instructional objectives, the research methods instructors were asked to indicate the degree to which the software

in Table 1 could be used to satisfy the eight common goals of a psychology major as specified in the McGovern report (McGovern, Furmoto, Halpern, Kimble, & McKeachie, 1991). The instructors' responses showed that, while most of the skills were addressed in similar ways before and after the upgrade, thinking skills and research methods and statistical skills were improved with the use of the upgraded laboratory.

Table 1 also lists the cost per unit of the software and, where available, includes an educational discount. Many of the vendors offer special prices for multiple copies and/or site licenses. Because student laboratories include multiple workstations, adoption of some of these programs can be quite costly. However, since the software can be used to support both instruction and research, it might represent an efficient allocation of a department's limited dollars.

Computers are tools for instruction, and as with all instructional tools, there is a need to keep them up to date. Sometimes there is a tendency to use instructional labs (once we get comfortable with a set of lab exercises) semester after semester without much thought to how methodology and instrumentation are changing. It is a continuing challenge to keep laboratories up-to-date and relevant for our students.

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