SESSION VIII

A SYSTEMATIC APPROACH TO COURSEWARE DEVELOPMENT

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A model for courseware development in psychology

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Many behavioral scientists are aware of the advantages of a systematic approach to research and the development of software used in research. However, coordinated and systematic efforts to develop instructional materials in the behavioral sciences are relatively rare. This paper and the symposium of which it is a part describe a systematic effort funded by FIPSE to assess the needs for microcomputer tools and courseware in the undergraduate curriculum in psychology and to stimulate the development of high-quality materials. The conceptual bases for development of materials are vertical and horizontal integration—the development of courseware that spans the curriculum from introductory to advanced, specialized, courses, and the systematic use of materials within a course and across courses and subject areas. The activities of the project, as well as implications for other computer-based development projects, are discussed.

Over the last decade, numerous computer-based instructional programs and packages (courseware) have been developed for use in the undergraduate curriculum in psychology. Many of these were adaptations of existing laboratory procedures and some were developed to suit individual instructors' curricular needs. Support for the development of some of the materials came from the National Science Foundation's LOCI, CAUSE, and ISEP programs. In most cases, such projects were designed primarily to meet local needs, with less attention paid to meeting the needs of the larger academic community. This paper and the other papers in this symposium describe the work of a task force funded by FIPSE (Fund for the Improvement of Post-Secondary Education), which was charged with reviewing the undergraduate psychology curriculum, assessing the need and potential for computer-based materials, and directing a systematic effort to develop integrated courseware with broad application in the psychology curriculum.

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An important goal of this project is not only to develop materials, but also to base their development upon well-assessed needs within the curriculum and to ensure that they embrace sound principles of instructional design. Thus, depending upon the topic and level, each module or unit may include drill and practice, autotutorials, problem solving, and simulation. Each module is a coherent lesson that teaches one or more concepts in one area in psychology.

Although we expect the courseware to be transportable and usable in a great variety of courses and on a large number of different microcomputers, we more importantly expect the method we develop to be generalizable to other projects.

In 1982, CONDUIT received a grant from FIPSE for the development of microcomputer-based materials in science. The disciplines included in the grant are biology, chemistry, physics, and psychology. This paper and the balance of the symposium describe the model being used in psychology to develop materials.

BACKGROUND AND THE NEED FOR DEVELOPMENT

For many years, the development of instructional software in psychology has been piecemeal. The earliest materials grew out of computer-based research laboratories. Faculty often teach in the same subject area in

which they do research. It is natural, then, to take one's students to the laboratory to see demonstrations or to participate in experiments. One problem with such activities is that the research is often at the cutting edge of development in an area, whereas the course attempts to demonstrate basic concepts and "classical" experiments in the field. The match of technology to substance and pedagogy in such situations is poor.

Many faculty faced with this problem began to write special-purpose demonstrations for their classes. Although this was a step forward and such programs could be used to good effect in one's own courses, the demonstrations often relied on special-purpose hardware and interfaces used for other purposes in the laboratory. As a consequence, the demonstrations were often idiosyncratic and extremely difficult to transport from one system to another.

Finally, even if the software was system independent and could be moved from one system to another with relative ease, it was very difficult to know how the demonstrations should be integrated into the relevant course. Many of the early computer-based instructional systems in psychology were "add-ons" to a particular course. That is, they were often optional exercises or projects simply added to the standard curriculum. Moreover, although the original developer/user knows exactly how to use the package, the documentation is seldom written to permit the package to be used easily by others. Thus, many faculty would obtain a package from a colleague, use it once, find that it did not integrate easily into their own courses, and discontinue its use at the conclusion of the term.

The progression of development outlined above is natural and should be expected in a new and rapidly growing field. However, as computing technology has matured, it has become increasingly obvious that significant advances in instructional computing can come only after careful examination of an entire curriculum and development of instructional material that are not only of high quality, but that also utilize recent developments in instructional design in the modules and can be easily integrated into a course. In addition to the ease of integration of materials into a course, it should be possible to integrate the computer-based instructional materials across the undergraduate curriculum in a systematic manner.

In order to achieve these goals, a task force was formed. One criterion for selection was that the participating individuals be involved in some form of computer-based instructional activities and be knowledgeable about current work in the field. In addition, it was essential that the representation be as broad as possible. As a consequence the membership came from small liberal arts colleges, mid-sized state universities, and large research universities. It was felt that a group so composed would be better able to balance curricular needs across the great institutional diversity found in this country.

OBJECTIVES OF THE TASK FORCE

Three major goals were set. The first goal was to identify the needs, especially the substantive needs, for computer-based instruction in psychology. This would be done in two ways: The undergraduate curriculum would be examined in some detail for the types of courses taught and the content of those courses. Next, this examination would be validated against a survey of faculty at several institutions to determine perceived needs. Although similar surveys of the psychology curriculum have been done in the past (Castellan, 1982), the high rate of change in computing dictates a need for frequent resampling. The results of this new survey are summarized by Butler (1984).

Next, we wanted to develop integrated courseware that would be as consistent in style and form as possible. Although research on human factors has shown the importance of a consistent and coherent underlying design for person-computer interaction, the fragmented nature of courseware currently available precludes such considerations. Moreover, we judged it to be important to enable the student to move easily from module to module within a course, and to move easily from the modules within one course to the modules in other courses, whether they were advanced courses on the same subject or courses in other areas. Thus, compatibility was a major goal. Another problem with courseware is that it is often developed by teachers; but good instructors are not necessarily good programmers. Because one goal of the FIPSE project is to develop materials that are not tied to a particular type of hardware, CONDUIT has developed a programming tool, AuthorAssist, which not only makes the coding task easier for courseware developers, but solves the problem of machine independence for the coding. More information about the use of AuthorAssist is discussed by Eamon (1984) as part of this symposium.

Finally, partly on the basis of our survey of major needs and partly on the basis of the substantive expertise of the individual task force members, we identified those modules or units of highest priority. These modules would form the first modules developed as part of the project; however, it is expected that other people will become involved in the project and develop additional modules.

THE UNDERLYING PHILOSOPHY: VERTICAL AND HORIZONTAL INTEGRATION

Underlying the design of the computer-based courseware in psychology is the idea of vertical and horizontal integration. Vertical integration refers to the ability to integrate the materials developed across courses in a particular topic from introductory to advanced levels, and horizontal integration refers to two other dimensions—integration across content areas and integration across instructional modes within a course. A schematic

Figure 1. Schematic representation of the dimensions of integration.

representation of this integration model is given in Figure 1.

Vertical integration refers to a design concept that enables a person to use portions of an instructional module in an introductory course, and as the student progresses toward advanced courses, the same module can be used for review of earlier concepts. In addition, in advanced courses, the module would develop basic concepts more fully, and illustrations would be more complete. Consider an illustration of short-term-memory processes. At the introductory level, the concept of short-term memory would be introduced and illustrated; at the intermediate level or in a methods course, the student might do a demonstration or simulation of short-term memory; finally, at the advanced level, the student might use the same module to design and run an actual experiment in the area. The core instructional module would be the same in each case, but as the student progressed, more detailed instruction could be obtained. This has an advantage across courses, and it also allows an instructor to refer students who desire or require advanced study on a topic to pursue such study easily.

As noted earlier, horizontal integration refers to two concepts: integration across different electronic media within a course and integration across subject matter within the discipline.

Integration within a course is accomplished by noting that there are many ways that the computer can be used in the classroom. One of these is by means of the "electronic chalkboard." Since this is covered in some detail elsewhere in this symposium (Spivey, 1984), it will be outlined only briefly here. Teachers have used chalkboards and overhead projectors in the classroom for many years. The electronic chalkboard combines features of each in a much more flexible and pedagogically useful manner. The ability to combine graphics, computing power (using perhaps a spreadsheet), and data retrieval enables the instructor to be extremely flexible. As an example, the instructor may have analyzed a set of data under two or three conditions and transferred the data to an overhead transparency. During the class discussion, some student invariably asks about the effect of parameter values other than those originally selected by the instructor. The instructor usually must guess and

then roughly sketch the result on top of a previously drawn graph. With the electronic chalkboard, the instructor is able to insert the desired values into the model and have the results plotted or displayed immediately. In addition, those students not in class can review the materials on the electronic chalkboard, and those students who wish to explore some concepts in greater depth or try parameter values of their own can use the chalkboard outside class.

The electronic chalkboard is integrated into the rest of the courseware. That is, materials in a course include, as appropriate, drill and practice, problem solving, simulations, demonstrations, and gaming. Each of these has a place in instruction and, if used properly, can enhance learning (Castellan, 1983). Taken together, these materials make up the *Electronic Study Guide*. These concepts are illustrated more completely by Spelt (1984) in this symposium.

The other aspect of horizontal integration enables computer-based courseware to be introduced and used more effectively in the entire curriculum, since redundancy and complementarity would be included in the instructional modules from the initial stages of design. Thus, the mode of use of courseware would be integrated across traditional subject areas in psychology.

CONCLUSION

Taken together, vertical and horizontal integration enables students to utilize microcomputer tools that share the same basic structure both across subject-matter areas and across the increasing depth encountered as the students explore advanced topics. A primary advantage of systematic organization is that the student may apply the software tools to the instructional task without getting drawn into superfluous but vexing problems of syntax, incompatibility, and inconsistency. The materials being developed are compatible in style and approach. Moreover, the materials are highly interactive, use dynamic and appropriate graphics, are supportive of student mastery of the relevant subject material, and exploit the computer "as a tool" for extending students' mental capabilities.

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