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# SESSION 5 TOOLS FOR COURSEWARE DEVELOPMENT

*Chaired by* Peter A. Hornby, State University of New York at Plattsburg

# Computer-Based Precision Learning: A Course Builder application

CLAUDIA E. McDADE
*Jacksonville State University, Jacksonville, Alabama*

**An interactive tutoring and evaluation system, the Computer-Based Precision Learning System has been evolving at Jacksonville State University since its inception in 1978. Based on the Precision Teaching goal of developing fluency in learners, the Computer-Based Precision Learning System reinforces high frequencies of correct student responding. The system relies on the flexibility of Course Builder, a symbolic, icon-based programming language for Macintosh microcomputers. Course Builder is described from both the designer's perspective and the student's perspective. Its strengths and weaknesses are also discussed. Data from three semesters of a personality theories course indicated that students quickly reached mastery on the system, performing at over 22 correct responses per minute. Their fluency generalized to essay performance as well. Implications for using the Computer-Based Precision Learning System to develop measurably effective instructional strategies are discussed.**

Education can be seen as the establishment of complex, discriminated performances with emphasis on student action. It is not what the student "knows" that matters; it is what the student can do. Additionally, controlling stimuli may have never before existed in the learner's experience or in the universe at large. The desired behavior may have never been emitted by the learner or by anyone else—let alone, been previously reinforced. Educational stimuli, thus, may be thought of as problems, concepts, or principles. Appropriate educational behaviors must be described in terms of necessary or prescribed functional results, rather than correct responses to particular instances of stimuli. Exemplars of concepts or principles must possess essential characteristics that differentiate them from one another.

Traditional shaping is increasing the probability of an explicit response by following successive approximations to the desired behavior by an effective consequence. Education differs from shaping because the desired response cannot always be specified before its occurrence. Once the response occurs, it can be evaluated as correct or not. For example, $E=mc^2$ was clearly the appropriate response only after its occurrence, since no one had conceived it before. A difficult practical question in education is, exactly what does the teacher or the instructional environment do to reinforce or extinguish various behaviors to produce desired fine discriminations that are yet to be specified? Computers provide a tool to analyze correct instances of this process. Reinforcement rules can be specified with the response evaluated for correctness and, thus, reinforcement. Analysis can then lead to establishing the most expeditious instructional routes to concepts or principles.

To determine and implement measurably effective instructional strategies, Jacksonville State University developed the Center for Individualized Instruction—a multipurpose, multidisciplinary academic support activity. In addition to providing tutoring in core curriculum courses and courses in developmental skills, the Center assists faculty from throughout the university in developing effective instructional technologies to deliver their courses (McDade & Olander, 1987). An indication of the Center's

Correspondence should be addressed to C. E. McDade, Center for Individualized Instruction, Jacksonville State University, Jacksonville, AL 36265.

 

effectiveness is the fact that over one half of the student body uses it each year.

From its inception in 1978, the Center for Individualized Instruction has been data driven. Beginning with a careful analysis of the educational process, which is continually updated, Center staff has developed a measurably effective, easily transportable instructional technology. It was founded on two educational principles developed elsewhere with considerable empirical, as well as paradigmatic, support. First is Keller's (1968) seminal realization that it is unproductive for students to progress to new material if the prerequisite concepts are poorly grasped. The second is Lindsley's (1956) not-so-obvious discovery that a relatively high rate of correct performance produces a dramatic increase in long-term retention. One of the most powerful instructional tools ever developed (Binder & Watkins, 1989) is Lindsley's Precision Teaching/Learning, which requires students to demonstrate high levels of accurate, *fluent* performance. For example, students are considered fluent in a unit of material in an undergraduate personality theories course, when they can answer questions on the Computer-Based Precision Learning System at a rate of at least 12 to 20 correct responses per minute. Students who reach high fluency levels outperform traditionally taught students on both subjective and objective tests (McDade, Rubenstein, & Olander, 1983; Vance, Brown, & McDade, 1992), and they retain the material longer (Olander, Collins, McArthur, Watts, & McDade, 1986).

Designing successful computer-assisted instruction (CAI) requires two basic tools—an effective instructional technology and a flexible, user-friendly authoring system. The Center's Computer-Based Precision Learning System provides a case history of CAI development, as well as a human learning laboratory for modifying instructional variables. Evolving over the past 13 years, Computer-Based Precision Learning relies on Precision Teaching strategies (Lindsley, 1972; McGreevy, 1983; White & Haring, 1980) for its pedagogy and Course Builder (Appleton, 1986) for its programming.

After 11 years of developing software to deliver electronic Precision instruction, staff in the Center for Individualized Instruction recognized the need to progress to more sophisticated and more reliable software than could be produced by students in computer science or by university faculty working as lay programmers. As microcomputer software has become more complex, it has become difficult for content specialists, such as psychologists, to develop competitive programs on their own. The Center needed a course authoring system that could accurately time student performance to produce rate data, as well as produce user-friendly courseware. After an exhaustive search for a flexible, interactive course authoring system for use on Macintosh microcomputers, Course Builder was identified. At the time (1989), only two interactive course authoring systems were available for the Macintosh—Course Builder and Authorware Professional. With Course Builder, nonprogrammers can relatively easily develop interactive presentations, self-paced learning sequences, intelligent tutoring systems, customized performance reports, and simulations. Course Builder was chosen because it is more cost-effective and easier to learn. Technical support is available from TeleRobotics, Inc., by phone, fax, or modem. Since it is located near Knoxville, Tennessee, Center staff can reach TeleRobotics for training and consultation in a matter of hours. Courses developed are royalty free. It is unnecessary to buy a copy of Course Builder for each computer. Only the developer needs a copy to design courseware, which can be distributed as a stand-alone application.

Course Builder offers the course designer flexibility in creating courseware. Using a visual course map (i.e., flow-

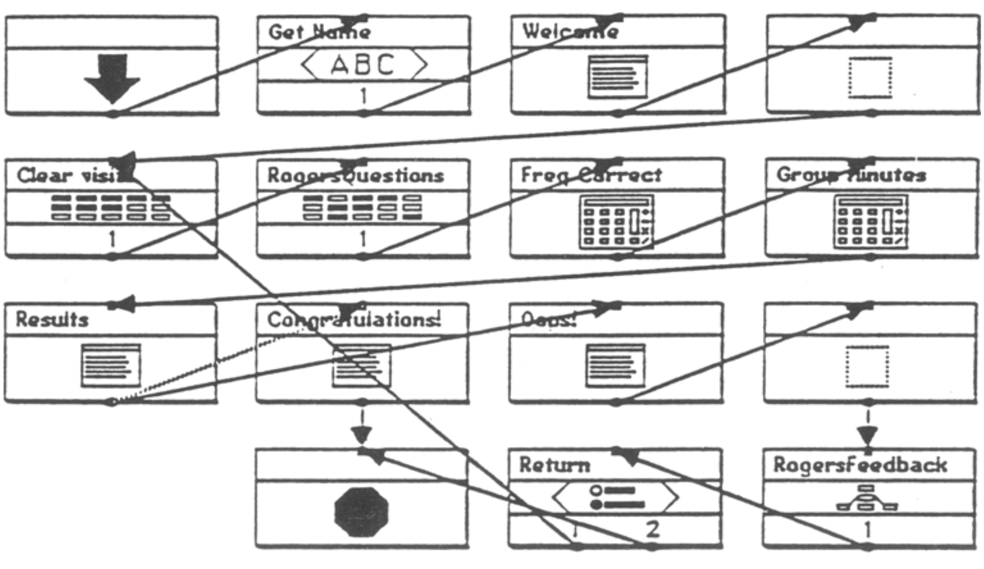


**Figure 1. Course map for Rogers unit in personality theories course.**

chart) to outline the sequence of a unit, Course Builder allows the designer to organize presentation order and routes connecting various states—the basic building blocks of Course Builder. A typical course map, as seen in Figure 1, displays states as rectangles. Six basic tools create 26 possible states. Routes are the paths that connect states together and can be direct or conditional.

Output states present information to the learner in the form of text, color, graphics, animation, sound, hypermedia, and interactive videotape/disc technology. Input states allow student responses and their evaluation. The designer can ask students to specify a region by pointing to it with the mouse (e.g., with a picture or map) or to choose one answer from an available selection with a radio button. In addition, one can specify a set of correct answers for a question. The input state also evaluates the correctness of the student's answer on the basis of conditions assigned by the designer. For text or numeric inputs, a parsing system allows the designer to accept approximations to the correct answer with varying feedback statements. If spelling is not important for the course content, varying acceptable spellings can be accepted. For numeric inputs, such as those in a statistics course, the designer might award full credit for answers correct to two decimal places, lesser credit for close answers within a given range, and no credit with a hint for correction beyond the acceptable range.

Group states organize individual states into hierarchies with optional sequencing methods. A random pool, for example, selects from a designated number of states randomly, whereas a linear group sequences through the states left to right, top to bottom. Flow states assist routes and groups in defining course sequence among states or other applications without the need for a connecting route. Routes can be replaced with bridges that can move to other courseware documents, supporting very large courses, or can move to other Macintosh applications. A random number generator is included in the numeric calculator, as well as a time-delay option. While some common educational calculations are built into Course Builder, such as total correct and percent correct, numeric calculators can customize the courseware. Link states allow the designer to tie courseware to external information, code, devices, or networks. HyperCard or an external video device can be accessed with link tools. Course Builder offers an extension tool that allows user-programmed code to be implemented within the Course Builder framework. This could be used to control external devices or design customized applications, such as creating a Standard Celeration Chart (a semilog graph) of student performance data on-screen.

The major weaknesses of Course Builder include inability to copy or print some inputs, lack of powerful tools to affect all states, and inadequacies in reporting functions. Once questions are typed into output states, they may not be printed to verify correctness or balance. Although the course map can be printed, once most states are open, their contents cannot be printed. Cut and paste functions are not available under all conditions. Macro tools should allow a given modification to all states, but Course Builder requires each state to be opened individually and modified. For example, if the designer decided to place a timed Continue button on each text output state, each state would have to be opened and the button added. Course Builder has a tutorial manual that is an improvement over earlier versions. However, it could use a technical reference manual. A more technical manual might assist the developer in knowing what the constraints in design are before attempting them.

After a short orientation, any student can access a unit on the Computer-Based Precision Learning System. A network version asks the student to sign on with a password and to choose a unit to study. Access privileges can be specified, so the student cannot go on to units he or she is not qualified to access or to units in other courses on the system. After sign-on, the student enters his or her name. A message gives the mastery requirement of the unit chosen. Once the student presses the Continue button, questions come onto the screen one at a time, drawn at random from the large item pool. Currently, in the personality theories course, all questions are multiple choice with only one correct answer allowed. Students use the mouse to click on an alternative. They quickly learn to direct the mouse with one hand to any space on the line of the correct answer and to press the return key with their other hand. Once the unit's questions are answered, immediate results are provided. The student is told the number correct, percent correct, total time, and frequency of correct responding. If the results exceed minimum mastery, the student receives a congratulatory message and exits the unit. If mastery is not reached, the student is shown the correct answer for each question missed and asked whether he or she wants to return later or to continue through the unit again. Although sampling of items is done with replacement, the larger the item pool, the less likely the student will see the same questions in subsequent passes.

In spring 1990, Computer-Based Precision Learning using Course Builder was piloted in the Center for Individualized Instruction to support several university courses, including PSY 335: Personality Theories. On the basis of results of this pilot, Center staff encouraged TeleRobotics, Inc., developers of Course Builder, to modify the symbolic programming language to incorporate design enhancements. Instructional technology transferred to electronic technology, which resulted in the birth of Course Builder 4.0. Beta-tested in the Center for Individualized Instruction, Course Builder 4.0 is continuing to be upgraded on the basis of *student performance data*.

Specific use of the Computer-Based Precision Learning System is illustrated by three semesters of student data from PSY 335: Personality Theories. Students enrolling in this elective undergraduate course at Jacksonville State University are required to reach mastery on a given personality theorist, defined as a fluency of 12 to 20 correct responses per minute on the Computer-Based Precision Learning System, by the date of class discussion on the theorist. Until that date, they may access the system as frequently as necessary to reach mastery. They then participate in two class discussions per week, write 12 essays, and take unannounced comparative and retention quizzes of course material.

Over the last three semesters, the average highest performance in the unit on individual theorists was over 22 correct per minute; the average number of attempts to mastery was 9. The students' essays tend to be succinct answers to the questions rather than incoherent ramblings with incorrect use of concepts. Students given 1 min to identify novel statements as belonging to given theorists perform at an average frequency of 12.5 correctly evaluated and written per minute. Within this system, *every* student reaches mastery, although the rates vary. Even with the demands of lab time, class discussions, essays, and pop quizzes, PSY 335 is a very popular course. The vast majority of students earn an A—not because the course is easy, but because it guides them through their learning. The instructor consistently receives the highest student ratings of instructor effectiveness in the entire college, as well as the Psychology Department.

The Center for Individualized Instruction encourages any faculty member at Jacksonville State University to offer any course using the Computer-Based Precision Learning System. Faculty design the questions and bring them to the Center, where the staff types in the questions and adjusts the mastery criteria according to faculty preference. Courses from anthropology, archeology, biology, geography, history, mathematics, political science, and psychology have been developed. As texts are changed, faculty typically leave the old questions and add new ones. Since the system provides tutoring and testing without penalty until mastery is reached, the student will learn from information presented by the former text's questions as well. The Computer-Based Precision Learning System template is available as shareware for faculty from other sites who wish to develop their own units. A complete courseware package for faculty from other institutions is available on a contractual basis.

On the basis of student performance and feedback, reinforcement rules in the Computer-Based Precision Learning System can be easily modified. Correct frequency aims (i.e., required mastery criteria) for a class can be determined on the basis of highest frequencies reached by students completing a unit in an earlier semester. If student comprehension of concepts and principles discussed in essays is less thorough than the instructor desires, questions can be changed to reinforce such comprehension. The Center for Individualized Instruction's Computer-Based Precision Learning System is both an effective instructional technology resulting in high student performance and an on-line data-collection instrument. It is an excellent example of the potential that computer-assisted instruction has for providing thorough, individualized learning that can be continually assessed and improved.

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