Programmed Instruction Overview

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INTRODUCTION

The history, efficacy, and impact of programmed instruction (PI) range from the rudimentary teaching machines of the 1920s to present-day computer programs and Internet activities that industry, military, and educational institutions use to teach everything from Hebrew to military law. Although PI was originally developed to teach basic academic skills, this overview describes its evolution, research on its effectiveness, and contemporary applications worldwide.

PI is one of the earliest teaching methods derived from behavior analysis. It involves analyzing comprehensive concepts into small, sequential tasks that teach, test, and self-correct in units referred to as "frames." A PI textbook often includes 1,000s of frames that require students to read a short statement, answer a question, and retrieve the correct answer before progressing to the next frame. Early PI lessons followed a linear sequence; however, the capabilities of the computer to "branch" based on correct and incorrect responses currently support nonlinear PI. From the teaching machines of the 1920s to the modern information superhighway, PI has evolved while retaining its behavioral roots and approaches.

HISTORY OF PROGRAMMED INSTRUCTION

Behavioral psychology provided the basis for PI with the application of Skinner's behavior analysis to learning. It grew from the teaching machines and autoinstruction developed by Sidney L. Pressey during the 1920s and the early 1930s. Pressey's machine was a simple multiple-choice testing device. A question and answer sheet was inserted into a simple wooden box with two levers. The question would appear in a window with the four choices for answers, and students would select the lever that corresponded to their answer. If the students answered correctly, the next question appeared in the window. If they answered incorrectly, the question remained in the window and an error mark was tallied in a separate window on the box. In this manner, an accurate count of incorrect guesses could be tracked. However, Pressey's approach focused on assessment and feedback only, and did not include instruction, a key element of PI.

B. F. Skinner (Holland & Skinner, 1961) perfected the use of the teaching machine to deliver the instruction, assessment, and feedback that define PI. He described his machine as a frame of incomplete textual or numeric problems that appear in a square window with sliders that are used to move the opening over each problem. When the student completed one problem, he or she checked the response by turning a crank to reveal the correct answer. The machine was able to sense the setting of the slider, and, if the student's answer was correct, moved a new problem into the window. Skinner recognized that his early machine was a low-tech device (evidenced by his statement that "a keyboard would be an obvious improvement"; p. 384); however, his rudimentary machine enabled him to demonstrate the efficacy and simplicity of PI.

Skinner argued that PI is more effective than traditional teaching methods because it is individualized, provides students with immediate corrective and reinforcing feedback, and enables students to follow a coherent sequence of instruction that is designed by experts in the field. And, although PI was a popular mode of instruction in the 1960s, its popularity faded almost as quickly as it emerged. Early PI packages were boring, isolated the learner, and were only useful for learning factual information. Unfortunately, the technology that early PI developers needed was a remote and expensive concept.

In the 1950s, IBM's Teaching Machines Project developed an IBM 650, a high-speed digital computer, and interfaced it with a typewriter to teach

math. The IBM 650 Inquiry Station was capable of transmitting typed information to the computer and receiving information from the computer. The student sat at the Inquiry Station, and the program of instruction in the computer presented the problem to the student by way of the typewriter. The student, in turn, typed his or her answers, which were transmitted to the computer for evaluation. IBM also developed a program called COURSEWRITER, the first computer language devoted to CAI (computer-assisted instruction) programming. However, the Inquiry Station was an expensive and cumbersome system that lacked present-day high-speed interfaces and portability.

Decades later, modern technology has revived an old concept and responded to Skinner's appeal for a keyboard, not to mention microprocessors that convey information at the speed of light. Currently, 10s of 1,000s of educational software products are based on PI and take advantage of technological advances that were little more than obscure concepts in 1961. However, the underlying approach remains the same; students set the pace, control the sequence, and receive immediate corrective and reinforcing feedback. Technology has transformed the old teaching machines into CAI that allows students to gain basic and advanced skills in a more engaging manner. Programs for school children, college students, military personnel, and employees in business and industry are only a mouse-click away.

EFFICACY OF PROGRAMMED INSTRUCTION

Decades of research have examined the effectiveness of PI as a teaching and learning tool. Early studies focused on linear models of PI that were used to teach basic skills in education. In *The Canadian Modern Language Review*, Mueller (1971) wrote a four-part series on programmed language instruction that addressed the use of PI to teach every aspect of language acquisition and application. Mueller contended that field testing of his PI programs resulted in more learning in less time than traditional language instruction. In a meta-analysis of nearly 40 PI studies, Kulik, Schwalb, and Kulik (1982) found that secondary students using PI earned higher test scores in science, math, and social studies than students being taught under more conventional methods. Several studies at the Prince Royal's College, Chiang Mai Province, on of the effects of PI on math, science, and Buddhist principle achievement showed that students using PI to learn math earned significantly higher scores than the control groups (Kosas, 1997; Saitum, 1997; Upara, 1999).

Programmed instruction has also been used and studied in the military worldwide. The British Ministry of Defense (1965) reported successful use of PI in 11 studies involving the Royal Navy, the Army, and Royal Air Force. Subjects such as military law, trigonometry, and regimental fund accounting were taught using PI. Pre- and posttest comparisons showed that military personnel using the PI materials scored significantly higher on the posttests and took less time to learn the material than personnel who learned the same material in a traditional classroom.

Studies in business and industry confirm the findings in the military and education. Ford (1983-1984) found that the use of PI to train health-care workers resulted in higher scores on posttests and greater employee satisfaction at a third of the cost of traditional training. O'Brien and Plooji (1977) successfully used PI to improve the attitude of Australian nurses toward aboriginal cultures. Mathai (2002) developed computer-based PI instructional modules to successfully teach "executive education" in industries in the Middle East.

In fact, 100s of studies support the use of either text- or computer-based PI to teach a wide variety of disciplines in numerous environments. Three findings are common: (a) students learn more in less time, (b) students express greater satisfaction with their learning, and (c) PI is more cost effective than traditional instruction. As the technological age continues to evolve, various forms of PI are likely to become the mainstay approach to structuring lessons that are supported by a solid research base on the effectiveness of PI.