Classic Programmed Instruction Design and Theory

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INTRODUCTION

This article discusses and advocates the principles of two qualitatively different and somewhat competing instructional designs from the 1950s and '60s, *linear programmed instruction* and *programmed branching*. Our hope is that an understanding of these ideas could encourage current and future instructional designers to adapt these techniques to new technologies and to use these techniques effectively. Although these older ideas do still see occasional mention and study (e.g., Brosvic, Epstein, Cook, & Dihoff, 2005; Dihoff, Brosvic, Epstein, & Cook, 2004), many contemporary instructional designers are probably unaware of the learning principles associated with these methods, originally developed for older generations of technology (cf., Fernald & Jordan, 1991; Kritch & Bostow, 1998; McDonald, Yanchar, & Osguthorpe, 2005; Sims, 2006). Cook (1964) had hoped in his era that we could "automate Socrates" with programmed tutoring and teaching machines that can take the place of a live teacher in some classroom activities. The present authors hope that online teaching has evolved to a point where instructional designers might recognize the value of individualized automated teaching and tutoring.

BACKGROUND

Although researchers have long shown interest in studying and advocating programmed learning and feedback devices since at least the 1920s (e.g., Pressey, 1926; Peterson, 1930), interest picked up greatly in the 1950s and 1960s with the behavioral psychologist Skinner's (e.g., 1954, 1958) experiments before again waning (c.f., Benjamin, 1988; Gentile, 1967; Petrina, 2004). In the midst of a period of widespread interest in machinery that enabled programmed learning methods, Finn (1960, p. 371) quotes himself as saying:

It is now possible not only to eliminate the teacher but the school system.

The complicated machines and very specialized programmed books of those days rendered neither school systems nor teachers obsolete as interest in such "latest instructional technology" began to fade through the 1960s.

Some might believe that currently cheap and easy distribution of lectures to tens of thousands of people via the Internet MOOC (massive open online course) holds the same promise made by Finn (1960). But like earlier machine-assisted learning technologies, the MOOC movement has experienced complications beyond cheap and easy distribution with doubts about how well it might eventually perform (e.g., Mackness et al., 2010; Pappano, 2012). While MOOCs might be problematic with the "mass teaching" aspect, they might be an answer to the problem of smaller-class teachers who are technologically challenged in online teaching environments (cf., Wallace, 2004).

Excitement over current technologies could give way to experiences of new technologies in the 1950s, '60s, and '70s. Fusco (1960) compared the mass distribution lecture of televised instruction experiments with programmed learning methods, noting that televised lectures were good for teaching a large number of students, but that programmed learning methods put the individual student in control of learning. The present authors note that lectures broadcast wirelessly via free "educational TV" is now a forgotten experiment that bears a remarkable resemblance to issues

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of MOOC lectures received via wireless Internet. A technical difference between these two eras, however, is that we now have a means to concurrently broadcast individualized instruction exercises that are based on the principles of *programmed learning*.

LEARNING AND PROGRAMMED INSTRUCTION

The remainder of this article is focused on automated programmed learning methods that were developed primarily in the 1950s and 1960s. We do not discuss them as methods that are universally superior to emerging methods such as mass-distributed lectures. We mean instead to say that we have the means to resurrect some classic ideas that are theoretically sound as potential replacements for a live teacher who is able to address the needs of individual students in a classroom. Just as a large lecture hall course is accompanied by assignments that are individually marked by a grad student or is accompanied by smaller lab sections, so, too, could a large distribution lecture be accompanied by non-human programmed learning modules that provide tutoring on an individual level.

Frase (1975) comments about the behaviors of the learner giving the appearance that teaching with technology is an art rather than a science, reminding us that the most important component of instructional technology is *the theoretical basis that should guide the content and form of instruction*. While the MOOC movement focuses on *the delivery* of "content" in a mass worldwide lecture hall, programmed instruction methods focus on *a theoretical basis of student learning* through programmable exercises that are suited to an *individual* level of learning via Internet delivery – whether the classes are large or small, whether they include talking-head lectures or not. That is, while many discussions of Internet-based instruction is focused on methods of delivery, the focus of this article is on methods of *instruction and learning*.

Learning through Linear Programmed Instruction and Programmed Branching

An important difference between these two instructional designs is associated with the use of feedback to the learner (something that isn't present in a one-way mass lecture). Although we could provide a student with, say, a score after completing an online multiple choice quiz, applications that provide more *immediate feedback* about correctness upon completion of each individual question have been found to better enhance learning (Brosvic & Epstein, 2007). Alternatively, we could provide *adaptive feedback* in which the application provides elaboration based upon qualities of a particular answer choice by a particular student (cf., Collis, De Boer, & Slotman, 2001).

The remainder of this article is focused on a comparison of two qualitatively different instructional designs, one providing immediate feedback regarding the correctness of a student's answer to a quiz question, the other providing adaptive feedback based on the qualities of the student's answer. Suitability of one design or the other is a function of the type of learner and of the learning outcomes that are desired. Both provide a form of *formative feedback*, intended to modify the individual learner's thinking to improve motivation and learning (Denton et al., 2008; Shute, 2008).

Although the idea of non-human feedback would seem to imply a mechanical or electronic device, other non-machine methods could be and have been used. Epstein and his colleagues, for example, have used a multiple choice form with an opaque, waxy coating that covers the answer spaces in a series of studies (e.g., Epstein, Brosvic, Costner, Dihoff, & Lazarus, 2003); when the learner scratches the opaque coating to select an answer choice, the presence of a star (or not) immediately reveals the correctness of an answer. Examples of the designs discussed below are based on paper books, but they are easily adaptable to technologies (e.g., html browsers) that use hyperlinks, drop-down menus, form buttons, and such. A brief example illustrating the use of drop-down menus to provide automatic tutoring that combines the principles of both *linear programmed instruction* and *programmed branching* is at http://www.sykronix.com/tsoc/courses/prin/pr_t1.htm.

Linear Programmed Instruction

The programmed psychology textbook of Holland and Skinner (1961) asked the student a question on one page (the quote below starts on page 2) and then asked the student to turn the page to find the answer and a new question:

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