FOREWORD

Most of education is still largely passive. Instructors talk and learners listen. We know that a driver learns more about a route than an accompanying passenger; yet today, learners too often remain “passengers” in our schools, training programs, and even in much of web-based instruction. Research reported herein verified the importance of learner participation. The programmed instruction (PI) format guaranteed meaningful student interaction via computer-based demands.

When one teaches swimming, one would expect to produce good swimmers. When teaching graphing, learners should then graph data well. This research verified performance by analyzing performance outcomes, not learner opinions, something not often done in research. It did not take the easy way out by using questionnaires for its primary data. It did not find educationally important differences between the treatments using this performance method, but the research proceeded in the right direction to pursue them.

Instruction in both treatment conditions conformed to the theoretical philosophy that instruction is most efficient when it is cumulative, linear,
and densely reiterative. Yes, exploratory learning is important, but not when the instructor has clear terminal performance objectives. In this study, software required learner performance evaluation at the rate of 1–3 times per minute—in the programmed instruction format. That format required 359 learner “thinking” responses during the tutorials. Participation in the PI treatment condition was overt construction—not selection/ recognition. This is a far more difficult task for students and significant because of this. It is also a more difficult task for computer software programming—especially via the web.

An important contribution of this study was the combination of measurement technologies drawn from applied behavior analysis (for the graphing performance task), computer technology, and a knowledge base arising from operant learning research. Its great strength is the blending of divergent fields.

“Treatment integrity” refers to the issue of whether an instructional technique is delivered precisely, consistently, and in the way described. A significant contribution of this study was to expose the lack of control that exists when instruction is accomplished at a distance and not under the close scrutiny of the creator of the instruction. We all avoid work—the things we have to do. Much of learning is not for the “fun of it” and students often take shortcuts.

In summary, this research revealed that some students escaped or avoided contingencies that might have been beneficial to them. The experimental results might have been quite different if 40 percent of students couldn’t have supplemented their learning through their own devices. For this, and the other reasons I have mentioned, I believe this research is truly trailblazing. It should prove helpful in the design of future research and application in the field of online instruction.

Professor Darrel E. Bostow
College of Education
University of South Florida
Completed in May 2003, the goal of this study was to determine if a difference in performance occurred among students presented with lesson plans using active, programmed instruction using constructed-response contingencies, and passive cued-text presentation of the identical material. Since May 2003, there have been literally hundreds of academic contributions and developments in the field that are relevant to this research.

It would be safe to assume that as computer- and web-based technologies continue to hold a place in the development of the modern curriculum, scholarly interest in web-based instruction will endure. The keywords “online learning” and “research” in any scholastic medium will yield hundreds of references to the field. Due in a large part to the realization of anticipated accessibility to low-cost, wideband internet access, researchers continue to pay attention to the application of “best practices” to the available technologies.

Two articles in particular come from the *Journal of Online Interactive Learning*. This journal of theory, research, and practice in
interactive online learning serves all disciplines and endeavors to provide a forum for the dissemination of research on interactive online education. They aim to disseminate ideas, further knowledge and understanding of emerging innovations and foster debate about the use and application of online education.

The aforementioned scholarly interest is evidenced in one particular review of online learning methods. Goldberg (2005) reviewed practices and processes for training faculty in the use of internet resources to build a hybrid or “blended” curriculum, combining aspects of face-to-face instruction with online learning. This study addresses a fundamental issue that I recognized in my 2003 study: The internet has indeed become a major element of the educator’s toolbox. However, educators should be cautioned that poor course design cannot be saved by technology. Goldberg also affirms my assertion that modern application of online learning resources leans toward a more constructivist methodology. An underlying assumption appears—the design of web-delivered learning materials should be tailored to the type of material being taught. Goldberg identifies a potential flaw in common instructional design thought, specifically that the behavioral approach of teaching tasks is rarely addressed and only assumed as a prerequisite for using specific learning software.

Goldberg posits that the behaviorist approach, characteristic of Skinner’s programmed teaching design of modeling and direct instruction, is recommended for teaching the technical areas of web-enhancing courses. The study then espouses a “project-based” progression into the course material. Implying a more constructivist methodology of “learning by doing.” Goldberg suggests that faculty construct specialized web pages as project-based exercises to advance beyond the technical tasks learned through programmed instruction. Depending on the project and instruction, Goldberg infers that behaviorist educators could reason that this methodology is characteristic of guided practice. At least in part, the precepts of instructional design using programmed
instruction, the basic contingency-response-feedback sequence are affirmed.

A second study, Chang and Ley (2006), is of particular significance. These researchers investigated the relationship between achievement and the quantity of online course materials that students printed and the frequency with which they reported using them. They addressed a significant factor in my study: That of experimental treatment integrity. Dividing their students into three groups: Print, onscreen, and no preference, this study found that onscreen preference learners had higher mean rank scores than print and no preference learners. There were no achievement differences between the online and hybrid learner groups. Learners who printed more preferred reading from printed online materials and experienced more onscreen reading difficulty than learners who printed less. In my study, students reported printing materials and using them for study prior to the computer posttest used for the evaluation.

It can be a difficult task, indeed, to account for individual study techniques and reading preferences. These factors must be addressed, however, in any experiments delivered in an uncontrolled environment over the internet. Chang and Ley (2006) tends to support my position that student study techniques could lead to potential problems of “treatment integrity” when experimental research is conducted over the web without supervision and insistence upon treatment delivery.

In my estimation, the enduring interest in the analysis of internet-based instruction shows that online learning remains an important area of research. I hope that this study proves itself beneficial to future research. Consistent with Cambria Press publishing policies, this work has complete documentation and methodology so that future scholars may build upon this work.
ACKNOWLEDGMENTS

The author wishes to thank those people whose invaluable assistance contributed to the completion of this volume. Appreciation goes out not only to those graduate students who participated in the study, but particularly to Mike Cohen, Darrel Davis, and “Gummi” Heimisson who personally supported this undertaking, putting in their personal time to help to gather the experimental data.

Thanks are especially extended to Dr. James White and Dr. William Kealy for their advice and inspiration. Gratitude is extended also to Dr. Stanley Supinski, a mentor, advisor, and friend.

Finally, this publication would not have been possible without the expert guidance of the author’s esteemed advisor, Dr. Darrel Bostow. Not only was he readily available, as he so generously is for all of his students, but he always responded quickly and honestly to the myriad of issues that the author presented in the process of this endeavor. Although not a man of many words, his oral and written comments were always extremely perceptive, helpful, and appropriate.
Of course, despite all the assistance provided by Dr. Bostow and others, the author alone remains responsible for the content of the following, including any errors or omissions, which may unwittingly remain.
PROGRAMMED INSTRUCTION IN ONLINE LEARNING
“I believe that consciousness is essentially motor or impulsive; that conscious states tend to project themselves in action.” This excerpt from philosopher and educational theorist John Dewey’s “My Pedagogic Creed” (Dewey, 1897) was later expounded upon in what could arguably be his most important work in the field of educational theory (Dewey, 1916). In “Democracy and Education,” his assertion was straightforward. Students learn by doing. Empirical support for this assertion, in the context of active response during instruction, has been afforded by substantial and mounting research in education and behavior. Using both group-comparison and single-participant experimental approaches, researchers have come to the same conclusion: Learning is enhanced when the frequency with which students actively respond during instruction is increased (Bostow, Kritch, & Tompkins, 1995; Cronbach & Snow, 1977; Gropper, 1987; Kritch & Bostow, 1998; Kritch, Bostow, & Dedrick, 1995; Lunts, 2002; Rabinowitz & Craik, 1986; Rickards & August, 1975; Skinner, 1950, pp. 68–72; Thomas & Bostow, 1991; Tudor, 1995; Tudor & Bostow, 1991; Williams, 1996). In programmed
instruction (PI), this active response allows the learner to control the advancement of the tutorial, incrementally progressing though the lesson material, and sequentially building up to the desired terminal behavior. “Learner control” in this behaviorist perspective is defined in terms of reinforced response to discriminative stimulus. This perspective holds that a student will learn as a result of being positively reinforced for having exhibited a specific observable behavior based on a particular contingent situation (Skinner, 1969).

Education in general, and the cited research in particular, has gone through an evolutionary progression. Programmed instruction grew from verbal and paper-based programs of study to teaching machines that provided automated instruction and facilitated learning by providing for immediate reinforcement, individual pace setting, and active responding. The emergence of technology in the last century and its continued advancement has broadened the perspectives of educational research. Studies using computer-based methods for delivering programmed instruction (Bostow et al., 1995; Kritch & Bostow, 1998; Kritch et al., 1995) have validated the significance of technology and its application in educational research and methods. A more recent influx in the field is the growing availability of high-speed, Internet-based distance learning. Despite these studies and the ostensible value of active learner response during instruction, much of what currently passes for computer- and web-based instruction does not use the basic contingency–response–feedback sequence. A learner can survey most web-based learning landscapes at his / her discretion “clicking” hyperlinks here or there, as desired, and advance to new material based upon his / her own criteria. Rather than progressing though a programmed course of material to focus the learner’s attention on the desired behaviors, the student is allowed to follow his own interests, potentially skipping material that may seem uninteresting, to advance without complete understanding, and so on (Butson, 2003). Part of the reason for this could be that evaluation of a learner’s performance on a
web site is more difficult than in the traditional classroom environment. In the classroom, a teacher can observe student responses such as body language and facial expressions and provide more personalized instruction. This close student–teacher environment is a challenge to replicate in a web-delivered course. It is easier for instructional web designers to build educational material that is static and browsable rather than material that provides feedback, as well as adjusted stimulus, based on learner response.

Perhaps a more critical reason, however, for a passive presentation of lesson material may relate to the creator’s philosophy of instruction. The role and importance of program-delivered instruction and correction is possibly not well understood or—of possibly greater concern—even discounted. It is argued, on the one hand, that the student must construct his own knowledge, while others maintain the control and guidance of the student in sequential, programmed steps of active response bring about more complete skills and capabilities. To date, these lines of reasoning have been tested and compared using paper-based lessons, teaching machines, and more recently, the computer-based methods of instruction. The advent of personal computing and the exponential growth of educational technology have generated many questions as to how the computer can supplement, improve, or perhaps replace established teaching methodologies. The internet is becoming a large part of the educator’s toolbox. Web-based offerings in many academic disciplines are redefining the educational landscape and readily available high-speed access to the World Wide Web is shaping the field of distance learning. Kritch and Bostow (1998) studied the effect to which the degree of constructed-response interaction affected learning outcomes in computer-based programmed instruction. This study evaluated the importance of learner activity in computer-based programmed instruction. Four groups of undergraduate students experienced computer-delivered instructional programs, with varying degrees of interaction, which taught the use of a computer authoring language. Results revealed
a clear superiority in both posttest and application performance with respect to those students who experienced the high density of active and meaningful participation. Performance of the passive group was the poorest. The present systematic replication was developed, in part, to substantiate the reliability and generality of the Kritch and Bostow (1998) findings. Contributing to mounting empirical data, this study extends the line of research in the field of “constructed-response interaction” in computer-based programmed instruction.

This study, however, identified some potential deficiencies in Kritch and Bostow (1998) that helped to direct its development as a systematic replication. This study seeks to address the following questions:

- Are the results generalizable to different types of curriculum material?
- Did Kritch and Bostow (1998) account for the possibility of cueing in their high-density active group, compared to the text-based passive group?
- Would the technology available today, in terms of web-based instruction, have any effect on the results found by Kritch and Bostow (1998)?

To address the issue of generalization of the results, this study changed the subject matter content and type of the lesson material. Kritch and Bostow (1998) presented a lesson in computer programming. The level of abstraction of the material presented was analyzed by applying Bloom, Mesia, and Krathwohl (1964) taxonomy. While the outcome measures used by Kritch and Bostow (1998) tested the actual utility of the program produced by the participant students, the logical, sequential, and analytical skills needed for computer language programming are identified in the “analysis” category of Bloom et al. (1964) Cognitive Domain. At this level, the learner is able to assess lesson material in its component parts so that its organizational structure may be understood. This skill may
include the identification of the parts, analysis of the relationship between parts, and recognition of the organizational principles involved. In contrast, the lessons presented in this study taught proper techniques for presenting data by way of graphing. Achievement of the terminal objectives was measured by the final product in the form of a hand-drawn graph, and results of a computer-administered test. While the levels of analysis and recognition were still in play for these lessons, incorporating aspects of comprehension from Bloom et al. *Cognitive Domain*, the particular spatial and manual skills requisite in drawing a graph from given data can be attributed to the third and fourth categories, “precision” and “articulation,” of the Psychomotor Domain. At this level, skill has been attained. Proficiency is indicated by quick, smooth, and accurate performance, requiring a minimum amount of energy. The overt response is complex and performed without hesitation. In some cases the skills might be so well developed that the individual can modify movement patterns to fit special requirements or to meet a problem situation (Bloom et al., 1964). This study varied the type and category of the lesson material presented using the active and passive treatments. This was intended to expand upon Kritch and Bostow (1998) thereby generalizing the results to more varied academic disciplines.

In previous research, the comparison between active response and passive reading harbored a basic flaw. Participants who actively responded to instructional frames by “filling the blank” may have been inadvertently “cued” to the critical material in the lesson. The passive readers, however, had no point of reference or clue as to the critical material in their lessons. Answers to the posttest questions for students who had previously “filled the blank” might have been more easily recalled than by those who were not “cued” to the crucial material in the lesson. In this study, this issue of “cueing” was dealt with by a slight adaptation of the text-based, passive-treatment condition. This adaptation entailed the identification in the text-based materials of the key words and phrases by means of italicized text. The Publication
Manual of the American Psychological Association describes the appropriate use of italics to emphasize “a new, technical or key term or label.” Thus, to overcome the possibly confounding variable of “cueing” in Kritch and Bostow (1998), this study afforded the text-based passive learning group “cues” by the italicized emphasis of the key words and phrases in the material.

The question of delivery method derived from Kritch and Bostow (1998) led this study to bring the lesson presentation up-to-date. The internet is the biggest, most powerful computer network in the world. It includes 1.3 million computers used by millions of people in over fifty countries. As connections to the internet have increased and availability of high-speed service has grown, educators have more possibilities to overcome time and distance to reach students. Distance learning is the “new frontier” of education. This study focuses and modernizes the question of constructed response and its effect on learning by presenting the lessons using the World Wide Web as the medium of delivery.

Two web-based tutorials, one using programmed instruction and the other using text and graphics-based web pages, were employed to deliver identical lesson content, teaching the methods of measuring, and graphically recording active human behavior. For this study, programmed instruction is defined as the use of technology to deliver educational course material in sequentially arranged contingencies of reinforcement. This process, using computer- and web-based apparatus, enhances the paper-based teaching machines of the late fifties and early sixties. After completing the online lessons, the participants’ performance was assessed by directly observed, overt responses. The expected terminal performances for the tutorials in this instruction were (1) the appropriate selection from a variety of optional methods and visual arrays, (2) the formatting of data recording sheets appropriate to the behavior and setting, and (3) accurate selection of the proper recording method.

“Instructional Method” was the independent variable for this study. This variable had two levels—“active” Programmed Instruction and
“passive” Cued-Text and Graphics. Inherent in each of the two methods of web-based presentation are distinct levels of learner participation and control of lesson advancement. For the present experiment, programmed instruction represents “active” learner participation and “program advanced” lesson material. Learner participation in the Cued-Text and Graphics presentation is distinguished by “passive” reading of the lesson material and “learner advanced” lesson materials. Table 1 describes the relationship between the conditions, as well as the learner participation and lesson control assumptions in the independent variable.

To evaluate the relation between instructional method and performance, two dependent variables were identified in this study. Both dependent variables were assessment results. The first was a computer-based posttest that measured the student’s retention of the lesson material, and the other was a learned skill application that appraised the student’s ability to utilize the skill sets learned by actually assessing a set of data and presenting it graphically as taught by the lesson.

This research expounds upon theories of learning stemming from an experimental science. To make use of the rapidly growing field of web-based distance learning, the focus was to identify and validate a crucial component of interactive computer-programmed instruction. The study centered on a fundamental research question:

In two types of web-based tutorials, distinguished by the existence of constructed-response contingencies, is there a significant difference in performance outcome,
based on learner participation, and the control of lesson advancement? Specifically, “Will teaching method be related to graded outcome on a computer-based test?” and, “Will teaching method be related to outcome on the graded results of an applied task?”