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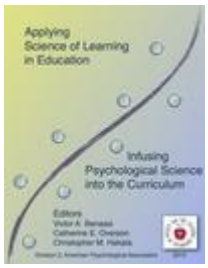

The Science of Learning Revisited: Findings Skinner Couldn't Have Known About and Theories He Wouldn't Have Cared About

A Review of

Applying Science of Learning in Education: Infusing Psychological Science Into the Curriculum
by Victor A. Benassi, Catherine E. Overson, and Christopher M. Hakala (Eds.)
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Reviewed by

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Sixty years prior to the publication of *Applying Science of Learning in Education: Infusing Psychological Science Into the Curriculum* (edited by Victor Benassi, Catherine Overson, and Christopher Hakala), B. F. Skinner (1954) wrote a treatise for the *Harvard Educational Review* titled "The Science of Learning and the Art of Teaching." In it, and in his other pronouncements on education, Skinner argued that the ills of the educational system could be cured by switching from reliance on aversive control (e.g., "the teacher's displeasure, the criticism or ridicule of his classmates, an ignominious showing in a competition, low marks, a trip to the office 'to be talked to' by the principal, or a word to the parent who may still resort to the birch rod," p. 90) to the systematic use of positive reinforcement. To this end, he argued that the curriculum must be redesigned to maximize the number of correct answers that students would produce and thus the number of positive reinforcements that they would receive and then to ensure that those reinforcements would be delivered instantaneously.

The vast majority of the research featured in the current volume came long after Skinner's time, and the differences between the two documents in the conceptions of learning and the account of the processes by which it occurs are numerous and profound. For example, in Skinner's behavioristic analysis, students learn arithmetic by acquiring a sequence of written or spoken verbal behaviors (1954, p. 90). The research and theory in Benassi, Overson, and Hakala's volume, however, are predicated on cognitive psychologists' belief that learning in mathematics and other subjects requires students to acquire a complex system of knowledge and skills.

Further, Skinner's conviction that immediate positive reinforcement is necessary for learning to occur is at odds with several of the chapters in this updated examination of how to apply the science of learning in education. For example, Hattie and Yates state that although immediate feedback is more efficient in most instances, delayed feedback also can improve learning (p. 52), and Pyc, Agarwal, and Roediger cite research showing that learning the correct answers to test questions is especially beneficial when students' answers have been incorrect (p. 83).

In their summary of the work of Bjork and others, Clark and Bjork note that introducing "desirable difficulties" (p. 21) can improve learning. Among the findings in this line of research, which is discussed in eight of the 14 chapters of the section that summarizes the science of learning (Part 1), is that conditions that are detrimental to performance during learning (i.e., produce more "aversive" student errors) can lead to better memory later on. These findings illustrate the difference between learning and behavior that is inherent in cognitive accounts of learning but impermissible for strict behaviorists.

The depiction of the science of learning presented in *Applying Science of Learning in Education* is based on what might be considered "mainstream" cognitive theory and research, often referred to as *information processing*. This is reflected as much by what isn't covered as by what is. Educators looking for insight into how best to apply *brain-based learning* or *multiple intelligences* in their instruction needn't look here because neither is mentioned. The notion that optimal instruction requires matching students' learning styles is alluded to in only two chapters (Chew; Taylor and Kowalski), and, in each case, the authors state that there is no evidence for the validity of the learning styles as a determinant of learning. None of the authors invokes the terms *constructivism* or *constructivist*, which are buzzwords in instructional design. Also missing are *situated cognition*, *distributed cognition*, and *embodied cognition*. Vygotsky's widely influential *zone of proximal development* (i.e., effective instruction occurs on the upper boundary of a student's capacity for independent work) is discussed in just one chapter.

On the other hand, *cognitive load theory* (e.g., Sweller, 2012), a tenet of instructional design (especially in educational technology) that is a direct outgrowth of cognitive models of working memory (e.g., Atkinson & Shiffrin, 1968; Baddeley, 2012), is discussed in several of the chapters of Part 1. Cognitive load theory holds that cognitive resources are limited; therefore, as more cognitive effort is spent on dealing with aspects of the learning task that are irrelevant to the material that is being learned (extraneous cognitive load), less is available to devote to learning (germane cognitive load). The beneficial effects of activities and strategies that promote active, meaningful processing of the material to be learned also are discussed in several chapters, as are those of multiple attempts to remember it (e.g., testing).

Despite its virtues, the current volume gets off to an unpromising start (p. 1) when the editors present a "formal," if tautological, definition of the science of learning as the "scientific study of how people learn" (Mayer, 2011, p. 3). They make a distinction between the science of learning and learning sciences without explaining it, other than to say that the science of learning is not just one field, and learning sciences is even broader (p. 1); however, they go on to explain that they have operationalized the science of learning in their book by focusing on cognitive psychology rather than on other fields typically included in the learning sciences (e.g., computer science, neuroscience).

Belying the emphasis on application implied by the book's title, more than twice as many chapters are in the section that summarizes research and theory in the science of learning than are in the section on putting them into practice in instruction (14 versus six; between the two is a section that addresses how to prepare instructors to apply the theories and findings of the science of learning to practice [four chapters, 40 pages], which I will disregard here in the interest of brevity). However, this apparent imbalance is offset by the fact that the editors directed the authors of Part 1 to finish their chapters with a discussion of how the principles that they present can be applied in instruction. The titles of most chapters in that section (and elsewhere) are straightforward and reflect the research-to-practice emphasis (e.g., "Using Feedback to Promote Learning," "Generating Active Learning").

Unlike many books of its type, this volume's focus is on the instruction of college students, but the editors claim that educators at all levels of instruction can benefit from some of the material presented. Evidently, the intended audience for this book includes not only instructors who are unfamiliar with relevant research in educational and cognitive psychology, but also those who are unfamiliar with articles in scholarly journals, as indicated by the editors' statement that the first chapter in Part 3 is "more detailed technically than the other chapters in this section" because they "wanted to include one example in the book of what original scholarly research looks like and we wanted to illustrate how much of the research on the science of learning and science of instruction is programmatic and systematic" (p. 3). They also offer suggestions on how to read the book.

Although little attention is given to the structure of knowledge, several authors distinguish between different types of knowledge, including declarative knowledge (i.e., factual knowledge), procedural knowledge (i.e., skills), and conditional knowledge (i.e., knowledge of when to apply procedural knowledge); domain-specific versus domain-general knowledge; conceptual knowledge; and metacognitive knowledge (i.e., knowledge of cognitive processes involved in regulating learning, problems solving, etc.). Presumably Skinner would have been indifferent to all of this, given his view that cognitive theorizing is unhelpful at best and misleading at worst.

None of the chapters in which the literature on the theory of learning is presented focus on motivation. It isn't mentioned in half of them and is invoked only briefly in the rest. This is surprising, given the central role of the learner's active processing of information in the construction of knowledge in the cognitive view of learning. Learners must be motivated to learn if they are going to acquire the knowledge and skills they need. The coverage of motivation is even sparser in the section on application. Even Skinner (1954) addressed the role of motivation in learning, albeit covertly, stating that in learning basic math skills,

> Some positive reinforcements were perhaps eventually derived from the increased efficiency of the child in the field of arithmetic and in rare cases some automatic reinforcement may have resulted in the sheer manipulation of the medium—from the solution of problems or the discovery of the intricacies of the number system— (p. 90)

which appears to be behaviorist code for intrinsic motivation and mastery motivation.

Although it is impossible to determine whether the authors of the applied chapters practice what they preach, one can at least examine whether they preach practices predicated on the previously presented principles of learning, and the results are mixed. For example,

Mayer's exposition of principles for designing multimedia instruction is matched with Overson's examination of the effectiveness of applying those principles in class presentations. Nguyen and McDaniel's examination of strategies for improving comprehension pairs nicely with Pazicni and Pyburn's examination of how to help students whose comprehension problems are having a negative impact on their learning of chemistry. The effects of testing and retrieving information from memory are examined in several chapters in Parts 1 and 3, but desirable difficulties are addressed in just one of the applied chapters, and discussion of cognitive load theory is missing.

I find it interesting that the book was commissioned by the American Psychological Association's Division 2, the Society for the Teaching of Psychology, because it should be equally relevant and helpful to faculty in all disciplines. Division 15, Educational Psychology, would seem the more natural home. In any case, *Applying Science of Learning in Education* is a great bargain; in fact, it's available for free at the URL shown above. At that price, it's well worth checking out for oneself.

References

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation: Advances in research and theory* (pp. 89–195). New York, NY: Academic Press. http://dx.doi.org/10.1016/S0079-7421(08)60422-3 PsycINFO →

Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology*, *63*, 1–29. http://dx.doi.org/10.1146/annurev-psych-120710-100422 PsycINFO →

Mayer, R. E. (2011). *Applying the science of learning*. Upper Saddle River, NJ: Pearson.

Skinner, B. F. (1954). The science of learning and the art of teaching. *Harvard Educational Review*, *24*, 86–97. PsycINFO →

Sweller, J. (2012). Human cognitive architecture: Why some instructional procedures work and others do not. In K. R. Harris, S. Graham, & T. Urdan (Eds.), *APA educational psychology handbook*: Vol. *1*. *Theories, constructs, and critical issues* (pp. 295–325). Washington, DC: American Psychological Association. PsycINFO →