

## **The Influence of Behaviorism on Elementary Arithmetic Teaching**

Eric Liu

Every behaviorist agrees that there can be a science of behavior. To measure the science of behavior, behaviorists had designed a set of analysis methods that all together is called behaviorism (Baum, 2005). However, behaviorism can be interpreted as a harmful implication or belief simply because the definition of the science and the behavior has never been universally agreed upon (Baum, 2005). Behaviorism was replaced by constructivism, which promotes free will, at the end of the twentieth century after dominating the psychological research area for more than sixty years. Although behaviorism is not a universal rule that can be applied to solve all issues, it could be very useful to aid the study of the science concepts at the early stage. By specifically narrowing down the definition of science and behavior, I claim that the behaviorism is still an effective theory to guide the early stage arithmetic education when the abstract concepts are difficult for children to understand at the beginning.

### **A Brief History of Quantitative Psychology**

Emerging from philosophy, psychology is the study of individual mind and behavior (VandenBos, 2015). Like other sciences that have originated from philosophy, psychology became an independent subject at the beginning of the twentieth century. As a “science of mind” (Baum, 2005, p. 6), the original introspective approach is considered as a subjective and unreliable measurement (Baum, 2005). To better measure the subjects, two branches of psychology came into sight: one is objective psychology and the other is comparative psychology. Objective psychology measures the mental process of choices by the reaction time. In this way, objective psychologists are able to replicate the experiments ran by others with the same methods. Comparative psychology,

impacted by evolutionary theory, focuses on the study of the differences between humans and animals in order to find out the general trait among different species (Baum, 2005).

### **A Brief History of Behaviorism**

At the beginning of the twentieth century, John B. Watson introduced the science of behavior that measures behavior by series replicable quantitative methods (Baum, 2005). In this way, observed subjects can be measured by quantitative factors that can be considered as scientific compared to the tradition ways of study. But the key concepts are still not clearly defined. For example, what behavior analyses should the research use to measure the behavior correctly? What type of behavior can be studied quantitatively? The unclear or non-universal definition left space for imagination or presumption among different behaviorists. This resulted in diverse interpretations of science and behavior (Baum, 2005).

B. F. Skinner is one of the best known behaviorists (along with John B. Watson) who focused on scientific explanation to a science of behavior. He claimed to be a radical behaviorist and labeled the psychologists with different view methodological behaviorists. At the end of the twentieth century, the dominant view shifted from objective to subjective. This resulted in the growth of constructivism, which recognizes free will as an essential element in addition to the heredity and environment. Constructivists acknowledge multiple realities constructed from inner world rather than one external reality (Driscoll, 1994). This is the major difference between constructivism and behaviorism.

## **Paradigms of the Research**

According to Amsel (1989), behaviorism is deeply influenced by the positivism, which only recognizes knowledge that can be discovered via observation and experiment. In this sense, any views or understandings from the personal mind or consciousness will not affect the existence of that knowledge. In other words, behaviorism challenges the idea of free will. Epistemologically, behaviorists believe that the learners can only obtain the single external reality through studying outside resources. Any subjective recognition from the learners should be excluded and are not credited (Bichelmeyer & Hsu, 1999). Thus, students are put in a passive rather than active position and undergo different types of conditioning stimuli to achieve learning goals.

For example, behaviorists attribute a student's correct answer to a question to successful conditioning rather than the understanding of the concepts from inside. In this sense, the way to keep the correct conditioning is by assigning good grades. In other words, students are positively reinforced by successfully replicating what they are told or behaving in a certain way required by the teachers. Without the dialectical process, students will never be able to actively participate in the study. The truth is determined by the teacher or by the accepted knowledge (Boghossian, 2006). This is true only at the early stage of study by ignoring the discussion of the correction of the accepted knowledge. Thus, behaviorism is a good guide to the teaching strategy by temporarily ignoring the subjective view from the students.

The methodology employed in behaviorism is positivist in nature. The principles of the behaviorist approach are based on psychological experimental analyses of behavior that tend to explain the relationship between learner's behavior and the environmental factors (Sidman, 1960). In the eyes of behaviorists, behavior can be observed and measured by quantitative variables. Lack of the attention on the student's subjective reason to learn,

behaviorists can only attribute the student engagement to the reinforced verbal behavior (Boghossian, 2006). As Crotty wrote, "it is only when propositions deduced from scientific theory have survived every attempt to refute them that the theory can be provisionally accepted as true" (1998, p. 32). Rigorous experimental design is planned not to prove a theory, but rather to test the validity of the relationship between the stimuli condition and the responses that follow (Skinner, 1966b). Concepts and principles derived from the experimental research are applied to improve the teaching practices (Baer, Wolf, & Risley, 1968). According to Crotty (1998), the axiology of positivism is value-free. Thus, bias needs to be removed under every condition. In this sense, behaviorists should avoid adding the personal values, expectations, and feelings onto any procedure of the scientific experiment.

## **Behaviorism and Education**

Psychology has blossomed through collaboration with other disciplinary areas (Piaget, 1978). The cooperation between psychology and education has offered educators principles and strategies for their daily teaching at the schools. By viewing the teaching process as non-rational, some psychologists not only provide the information that helps the educators assess teaching philosophy, but also propose research findings that are action-based to help them improve instruction (Bijou, 1970). For example, by presenting theoretical knowledge about the stages of cognitive and intellectual growth, psychologists are in the leading position to direct educators' instruction.

Behaviorism dominated the educational landscape for more than sixty years in the twentieth century (Boghossian, 2006). Attached to objectivity, "behaviorism views knowledge as resulting from a finding process, learning as a passive process of acquiring knowledge, and instruction as the process of providing knowledge" (Bichelmeyer & Hsu, 1999, p. 4). Guided by these principles, teachers take the central place of knowledge to share the

truth with learners, whose introspection and discussion do not contribute to the learning process. By ignoring the inner mental state of learners, behaviorism focuses on the study of external behaviors. Through the observation of the relationship between the conditioning stimuli and the response come after, behaviorists assess how the learning occurs and completes (Freiberg, 1999). If the study outcome is not ideal, it is the teacher and conditioning to be blamed.

Skinner believed that there is a direct relationship between development and stimuli (Cosgrove, 1982). Although his critics argued that his analysis of behavior came from the observation of simple animals and can never be generalized to the human nation, I still believe the theory fits for elementary arithmetic education. At the beginning of arithmetic study, children are in a responsive situation and the knowledge is passed from the teacher in one direction. Children are easily distracted by anything outside of the blackboard or the computer screen if they cannot understand the contents. Conditioning stimuli seems the only effective method to keep them focus on the study and so as to build up the automatic reinforcement (Cosgrove, 1982).

According to Skinner (1968), elementary education control has a long history of aversive stimuli. Students participated in study primarily to avoid punishment from birch rod to the teacher's displeasure, the criticism of 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.15)

The consequence of such stimuli may temporarily force the students to read numbers, memorize tables, and perform operations upon numbers but in the long run, the aversive control may result in anxiety, boredom and aggression (Skinner, 1968). Therefore, applying the correct conditioning stimuli in the classroom will not only lead to ideal learning outcomes, but also cultivate the children's mental health in the long run. Numerous recent studies

have proved the positive relationship between positive mood and performance and creativity (Cocu, Pecheanu, & Susnea, 2015). According to Cocu et al. (2015), "A happy person tends to think abstractly, while a person in a negative mood tends to think analytically and systematically." (p.175). This explains why a student who performs well in math, but with a negative mood, may not become a creative master in this area.

### **Critical Learning Features explained by Behaviorism, Cognitivism, and Constructivism**

Compared to behaviorism that believes a science of behavior in the learning process, cognitivism looks at the process from the cognitive science. Cognitivists try to construct a mental model to explain the acquisition of knowledge (Snelbecker, 1983). Without effective measurement tool, this attempt is simply supported by a series of unreliable statistical observations. Philosophically, both behaviorism and cognitivism are based on objectivism, which believes in existing truth beyond the human mind (Jonassen, 1991b). At the end of the twentieth century, behaviorism and cognitivism were replaced by constructivism, which emphasizes the effect of learner's own experience on the meaning of knowledge (Ertmer & Newby, 2008).

According to Schunk (1991), learning theory was explained differently through the lens of each theory. Cognitive theories believe that the learning occurs when the student's attention is triggered (Ertmer & Newby, 2008). The learning completes when the information is stored into student's mind through complex mental activity (Ertmer & Newby, 2008). Constructivists do not believe that knowledge is independent from human's mind. Thus, the learning occurs when people start to create the meaning of knowledge based on their own experiences (Ertmer & Newby, 2008). However, in elementary arithmetic teaching, children are not mature enough to explain the outside world information by their own experiences. The abstract arithmetic concepts will not cause children's attention. Therefore, the instruction based

on the two theories will not be effective for novice learners.

Behaviorists identify learning occurrence as a change of behavior, and learning completion as the correct response to the conditioning stimulus (Ertmer & Newby, 2008). Environmental conditions are the major factors that influence the learning (Ertmer & Newby, 2008). Humans memorize information by repeatedly receiving the stimuli and generalize the learned knowledge to the similar concepts (Ertmer & Newby, 2008). The principles of behaviorism are highly relevant to elementary arithmetic instruction that uses reinforcement to impact performance, measures the student's progress by the repeated tests, and constructs the desired behaviors by practices.

### **Instructional Design in Elementary Education**

To study individual differences, psychologists employ scientific experiments and try to disclose the causal or correlational relationships between the different testing groups. By making the conclusion based on the rigorous empirical study that can be generalized to the larger population, psychologists not only study the individual but also explore the common traits of humans in general (Piaget, 1978). As with other sciences that have been through different stages of development throughout history, psychology, as an independent subject, also experiences constantly reorganization because of the new findings. For example, Piaget's developmental stage theory was challenged by other psychologists who developed new theories that incorporate evidence that conflicts with Piaget's predictions. Also, the appearance of modern neuroscientific research has strongly challenged the existing psychological theories. Apparently, the development of psychological theory is propelled by a reflexive progress which is one major character of the natural science (Piaget, 1978).

According to Case and Bereiter (1984), behaviorist instructional technology was replaced by a seemingly better technology known as hierarchical task analysis due to three major

weaknesses: (a) failure of applying the principle of reinforcement, (b) failure of specifying the objectives of school learning, and (c) failure of identifying the behaviors that leads to the desired terminal behavior. Also, behaviorist technology was considered as a useful tool to manage the classroom rather than the ideal method to design instruction because of the orthodox definition of behaviorism (Case & Bereiter, 1984). However, the new approach was found ineffective with young children arithmetic teaching (Case, 1968a, 1968b). The diagnosis ascribed the failure to the limitation of the student working memory and naïve belief of an incomplete strategy (Case, 1968a, 1968b). Instead of reconsidering the behaviorism, researchers sought the specific solutions from theory of human cognition and development (Case, 1975). By adding development on top of the cognition, researchers expected a better teaching outcome than traditional behaviorism (Case & Bereiter, 1984).

In Case's (1978a) empirical experiment on a total sample of 54 children from grade four to seven, half were "math disabled" in grades six and seven, and the other half were normal in grades four or five. All of them failed in the pre-test. The two groups of students were further disaggregated into three sub-groups and received interventions based on the methods of cognitive development, cognitive behaviorism, and standard school curriculum. Nine normal students and nine "math-disabled" students who received intervention by the method of cognitive development passed a criterion of 65 percent success compared to the pass rate of only three normal students and one "math-disabled" student who received intervention by the method of standard school curriculum.

Needless to say, with the small sample size of nine in each cell, the teaching method itself does not have distinct features that differ from those based on behaviorism. For example, the three methods to reduce the working memory load are using structurally simpler unitary method instead of cross multiplication method, introducing one new feature at a time, and providing subjects with extensive practice (Case, 1978a). These fashions are

also good teaching strategies to construct the science of behavior if the researchers define the potential reinforce is a simpler method, identify the desired behavior is to study by practicing intensively, and move students through the sequence of behavior by use of demonstration of one new concept at a time. In essence, behaviorist instructional technology is a powerful approach in early elementary education by accurately defining the entering desired behavior, effective reinforcers, and desired behavior from experienced educators.

### **Behaviorism in the Twenty-First Century**

Behaviorism has value when it is applied to specific groups. The success of one group may be replicated by groups with the same or similar characteristics. A well-designed program will keep students engaged. Back to the root of behaviorism, audio and video are materials that serve as conditioning stimuli (Ertmer & Newby, 2008). In the twenty-first century, with the aid of multi-media and the Internet, educators are able to offer numerous conditioning stimuli to attain much better learning outcomes than before in elementary arithmetic education. The desired science of behavior in arithmetic study can be formed by incorporating multi-level stimuli from teacher, parents, multi-media resources, and online community. Once the science of behavior is constructed, students may become more confident with their learning capability and therefore, may continue to study the math by their own free will. Based on new technology and the characteristics of elementary arithmetic education, I believe behaviorism can be applied to produce positive effects in the elementary study of arithmetic among children who have never had exposure to the concepts.

### **Limitation of Behaviorism**

The limitation of the behaviorism is that only simple human behavior can be explained. The complex human mental activities can never be

measured by the behaviorists as well as other psychologists. Without further study of humans' mind and consciousness, it is hard to disclose the deeper reason why people learn. The initial goal of behaviorism was to produce a reliable and generalizable result in order to join the natural science family (Baum, 2005). In this sense, behaviorists have no contribution to educational strategies that considers learners' cognitive ability. In other words, advanced math instructional technology design should be based on cognitive theory or constructivist theory because students are mature enough to actively participate in the study (Ertmer & Newby, 2008).

### **Conclusion**

The transition from behaviorism to constructivism indicates the trend of emphasizing the value of free choice. The effective educational technology to the elementary children based on behaviorism might not be effective to the advance math instruction (Ertmer & Newby, 2008). However, even cognitive theory and constructive theory recognize behaviorism's model of instruction, reinforcement and feedback. As Skinner (1968) said, "The government of the future will probably operate mainly through educational techniques" (p. 260). This might be why we require young children to study math. Despite numerous math-oriented careers, math itself improves human logical capability. Therefore, it is clear that math is an important general education subject in the U.S. educational system.

### **References**

- Amsel, A. (1989) Behaviorism, Neobehaviorism, and Cognitivism in Learning Theory, in: *Historical and Contemporary Perspectives* (John M Maceachran Memorial Lecture Series). Hillsdale, NJ: Lea.
- Baer, D. M., Wolf, M. M., and Risley, T. R. (1968). Some current dimensions of applied behavior

- analysis. *Journal of Applied Behavior Analysis*, 1, 91-97.
- Baum, W. (2005). *Understanding behaviorism* (2nd ed.). Oxford, UK: Blackwell Publishing.
- Bichelmeyer, B. & Hsu, Y. (1999) Individually-guided education and problem-based learning: A comparison of pedagogical approaches from different epistemological views, in: *Proceedings of Selected Research and Development Papers Presented at the National Convention of the Association for Educational Communications and Technology (AECT)* (21st, Houston, TX, February 10–14, 1999). IR 019 753.
- Boghossian, Peter (2006). Behaviorism, Constructivism, and Socratic Pedagogy. *Educational Philosophy and Theory*, Vol. 38, No. 6, 2006
- Case, R. (1968a) "An analysis of the acquisition of a scientific concept by adults." *Unpublished course paper*, OISE.
- Case, R. (1968b). "Difficulties encountered by disadvantaged children in solving a visually represented problem." *Unpublished Master's Thesis*, University of Toronto.
- Case, R. (1975). "Gearing the demands of instruction to the developmental capacities of the learner," *Review of Educational Research* 45, 59-87.
- Case, R., & Bereiter, C. (1984). From behaviorism to cognitive behaviorism to cognitive development: Steps in the evolution of instructional design. *Instructional Science*, 13(2), 141–158. Retrieved from <http://www.jstor.org/stable/23368980>
- Cocu, A., Pecheanu, E., & Susnea, I. (2015). Stimulating creativity through collaboration in an innovation laboratory. *Procedia - Social and Behavioral Sciences*, 182, 173-178. doi: 10.1016/j.sbspro.2015.04.753
- Cosgrove, M. P. (1982). *B.F. Skinner's behaviorism*. Grand Rapids, MI: The Zondervan Corporation.
- Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Thousand Oaks, CA: Sage Publications.
- Ertmer, P. A., & Newby, T. J. (2008). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, 26(2), 43–71. <http://doi.org/10.1002/piq>
- Freiberg, J. (ed.) (1999) *Beyond Behaviorism: Changing the classroom management paradigm*. Boston, MA: Allyn & Bacon.
- Jonassen, D.H. (1991b). Objectivism vs constructivism: Do we need a new philosophical paradigm. *Educational Technology Research and Development*, 39(3), 5–14.
- Kalat, J. W. (1996). *Introduction to psychology. fourth edition*. Pacific Grove, CA: Brooks/Cole Publishing Company.
- Piaget, J., & Kamii, C. (1978). What is psychology? *American Psychologist*, 33(7), 648-652.
- Schunk, D.H. (1991). *Learning theories: An educational perspective*. New York, NY: Macmillan.
- Sidman, M. (1960). *Tactics of scientific research*. New York, NY: Basic Books.

- Skinner, B. F. (1966). What is an experimental analysis of behavior? *Journal of Experimental Analysis of Behavior*, 9, 213-218. (b)
- Skinner, B. F. (1968). *The technology of teaching*. New York, NY: Appleton-Century-Crofts.
- Snelbecker, G.E. (1983). *Learning theory, instructional theory, and psychoeducational design*. New York, NY: McGraw-Hill.
- VandenBos, G. R. (Ed.). (2015). *APA Dictionary of Psychology* (2nd Edition). Washington, DC: American Psychological Association.  
Retrieved from <http://www.ebrary>.
- Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review*, 20, 158-77.