

APPLYING BEHAVIOROLOGICAL PRINCIPLES IN THE CLASSROOM: CREATING RESPONSIVE LEARNING ENVIRONMENTS

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ABSTRACT

The application of behaviorological principles in the classroom has led to the development of an effective technology of teaching (Skinner, 1968); specifically, effective ways for teachers to be responsive to learners. A responsive learning environment is a systematically designed instructional approach based upon this technology of teaching. Antecedent (curricular) events are programmed to maximize instructional efficiency while minimizing errors in the teaching of new skills. Concomitantly, reinforcing consequences are arranged to ensure success in the acquisition, fluency-building, maintenance, and generalization of the new skills. Steps are described for changing ineffective instructional situations characterized by chronic failure into learning environments that are responsive, efficient, and successful.

What is a responsive learning environment? Let us begin by examining each term. Responsive means answering or making a reply; reacting easily, as "a responsive audience." Learning implies the acquisition of new skills; for example, things learners can do following instruction that they could not do before instruction. The environment is the immediate situation or milieu within which the learner is interacting. An environment may be social or physical. An appreciative audience, one that applauds good acting, is an example of a responsive social environment. Computer--assisted instruction that provides immediate performance feedback to the learner is an example of a responsive physical environment. Whether by design or by chance, individuals learn by interacting with events in their environments.

In short, we may describe a responsive learning environment as a systematically designed instructional situation based upon scientifically established principles of learning. In the classroom, these behaviorological principles have led to the development of an effective technology of teaching, the most important component of which is the responsiveness of the teacher to changes in the performance of the learner. This paper gives a brief overview of the basic principles of behaviorology, examines how these principles can be applied in creating responsive learning environments, and delineates a system of steps needed to transform an ineffective instructional situation into a learning environment that is responsive, efficient, and successful.

PRINCIPLES OF BEHAVIOROLOGY

With the publication of his book *Behaviour of Organisms* in 1938, B. F. Skinner contributed the experimental base for the system of behaviour that he called operant behaviour (sometimes referred to by other learning theorists as instrumental behaviour), thereby laying the foundation for the science of behaviorology. Operant behaviour differs fundamentally from the type of behaviour Pavlov studied, which Skinner called respondent behaviour. Respondent behaviour, consisting of conditioned and unconditioned reflexes, functions primarily in the physiological regulation of an organism (e.g., the salivary response elicited by food in the mouth). In contrast, operant behaviour functions primarily in the adjustment of an organism in relation to the external environment (e.g., catching a

ball). In ordinary words, we can think of respondent behaviour as "involuntary" and operant behaviour as "voluntary." It is called operant behaviour because it operates on the environment. More importantly, operant behaviour is controlled by its consequences; respondent behaviour is not. Although Pavlovian conditioning principles may be responsible for emotional reactions that affect classroom learning in one way or another (e.g., anxiety elicited by situations similar to those in which punishment has been experienced--see the chapter "Influencing Emotional Characteristics" in Schloss & Smith, 1994), they have little or no direct application in creating a responsive learning environment because they do not involve the arrangement of reinforcing consequences for engendering new skills.

What are the principles of behaviorology? Based on the causal mode called selection by consequences (Skinner, 1981), behaviorology is the science concerned with variables that control behaviour where behaviour is understood as the interaction of an organism with its environment. Analogous to the selection of species in natural selection, behaviour is held to be selected by the environment. An action occurs, producing a change in the environment--a consequence--and that change alters the future likelihood of similar actions in similar circumstances. Consequences that make an action more probable are called reinforcing consequences; those that make an action less probable are called punishing consequences. Thus, reinforcement strengthens behaviour whereas punishment weakens behaviour. When reinforcing consequences no longer follow behaviour and that behaviour decreases (or punishing consequences no longer follow a previously suppressed behaviour and that behaviour increases), we say that the behaviour (or its suppression) is being extinguished and the process is called extinction.

Through these processes of reinforcement and punishment, then, the environment selects (for or against) particular actions as a function of their consequences. No causal agencies originating within the individual such as cognitions, expectations, or intentions, are supposed. At the same time, however, behaviorology does not exclude "inner" or private events (e.g., imagining or thinking to oneself). But, importantly, such covert events are treated as no different in kind than any other behavioural phenomena--the fundamental premise of the philosophy of the science of behaviorology that Skinner called radical behaviourism (q.v., see Heward & Cooper, 1992). Nor does behaviorology ignore the investigation of symbolic processes. Two important areas of behaviorological research deal with such complex human behaviour: the study of human language as verbal behaviour (Skinner, 1957) and the study of symbolic meaning as equivalence relations (see Sidman, 1994). Applied research on the operant analysis of verbal behaviour (e.g., Sundberg, 1990) and of equivalence relations (e.g., Stomer, Mackay, & Stoddard, 1992) illustrate the experimental study of the socially important behavioural phenomena that contemporary cognitive psychologists regard as symbolic mental processes. (Unfortunately, the limited scope of this paper prevents further discussion of these important behaviorological research areas. For further information see past issues of the journals *Analysis of Verbal Behavior* and *Journal of Experimental Analysis of Behavior*; also Sidman, 1994.)

In sum, operant behaviour is the subject matter of the basic science of behaviorology.

Thus, behaviorology investigates the contingent relations between actions and their environmental effects--either reinforcing or punishing consequences, depending upon whether behavior is strengthened or weakened respectively. So far, we are dealing with a two-term contingency--an action and its consequences.

There is an additional contingent relation we need to understand before we can apply behaviorological principles effectively in creating responsive learning environments: the contingent relation between antecedent events and behavior. Consider a situation in which smiles and frowns are effective as consequences. If we greet someone who smiles and returns our greeting, we will be more likely to greet that person in the future (our greeting-behavior has been reinforced). But if we greet someone and that person frowns and says something unkind to us, we will be less likely to greet that person in the future (our greeting-behavior has been punished). On our next encounter with the smiling person, the sight of that person will become a positive cue (discriminative stimulus) for our greeting behavior. Conversely, on our next encounter with the frowning person, the sight of the person will become a negative cue (warning stimulus) to avoid further social interaction with that person.

These smile/frown examples show how an antecedent event, a cue, prompts an operant response. We respond to the person as either a discriminative stimulus or as a warning stimulus based on the consequences that followed our greeting behavior in the past. If the smiling person subsequently begins to ignore our greetings, the sight of that person would soon stop functioning as a discriminative stimulus; the positive cue effect would extinguish (although our smiling will continue in other situations where it is reinforced). In the other example, if the frowning person subsequently began to smile following our greetings, the cue effect of that person would change from a warning stimulus to a discriminative stimulus. With operant behavior (e.g., greeting someone), the capacity of an antecedent event to evoke the response is dependent entirely on past consequences, on the individual's past history of reinforcement or punishment in similar situations. These examples describe the functional relations that define the three-term contingency, the basic unit of analysis in behaviorology: a situation (cue), a response, and a consequence.

Just as the building of a well-constructed bridge must be based on the appropriate application of scientifically established principles of physics, the construction of a responsive learning environment must be based on the appropriate application of scientifically established principles of behaviorology. An extensive body of research literature (largely disregarded by educators) supports just how these principles have been applied effectively in the improvement of such skills as reading, mathematics, spelling, physical fitness, speech training, writing, language, verbal behavior, and even music, esthetics, and creativity (e.g., see Cautela & Ishaq, 1996; Cooper, Heron, & Heward, 1987; Miltenberger, 1997; Schloss & Smith, 1994; Sulzer-Azaroff & Mayer, 1991; West & Hamerlynck, 1992; Wolery, Bailey, & Sugai, 1988; also, *Education and Treatment of Children*, *Journal of Applied Behavior Analysis*, and *Journal of Behavioural Education*).

We turn now to some specific applications of behaviorological principles in the creation of responsive learning environments. (Sparzo, 1985, provides a concise and easy-to-read

introduction.) The most important consideration is to arrange classroom environments systematically so as to minimize errors and maximize the acquisition of new skills--an instructional method termed errorless learning (i.e., "when the removal of prompts is so carefully engineered that errors fall essentially to zero," Sulzer-Azaroff & Mayer, 1991, p. 314). A responsive learning environment is one that is highly responsive to the continuing performance of the learner. In an effective learning environment, tasks are both presented in carefully graduated steps and finely adjusted to the learner's progress so that a high degree of success is assured. In a responsive learning environment, the learner advances only after mastering prerequisite tasks--the essential but chronically neglected provision Skinner (1968) identified as the most common flaw in education.

Thus, to create an effective learning environment, it is essential to measure and monitor the continuing performance of each learner. The first step in doing so is to specify instructional goals in objective and measurable terms. In addition, we must specify what materials or levels of assistance may be needed to minimize errors and ensure success. Finally, we must precisely define success: How much of the task is to be completed? ... at what level of proficiency? ... under what conditions?

Vargas (1993) observed that "since behavior evolves through a selection process, it follows that student behavior must be central in the teaching process" (p. 8). For learning to take place, however, it is not enough that the learner simply do something; what the learner does must be successful, a point that cannot be overemphasized. Success generates more success. In more technical terms, behaviorologists say that when performance is reinforced, it is more likely to occur in the future. "Success," the reinforcing effects resulting from the learner's actions, can vary greatly and take many forms from one learner to another. Ideally, accomplishment itself functions as effective reinforcement. For example, correctly dividing one fraction by another will increase the likelihood of solving similar problems in the future. Reading a short story and writing correct answers to comprehension questions about the story will also affect future performance, provided, of course, that correct answers function as reinforcement for the learner.

On the other hand, requiring learners to perform tasks for which they are not adequately prepared will probably have the opposite effect. Failure generates more failure, the performance-weakening effect we call punishment. When a learner's actions are followed by punishing consequences, such as the experiences of failure when attempting academic tasks, those actions will be less likely to occur in the future. For example, the learner who has not learned to multiply numbers proficiently will experience failure when attempting to divide fractions. The learner who has an insufficient vocabulary will experience failure when attempting to answer questions over reading selections. In both cases, the learner is destined for failure; working on math problems or writing answers will become punishing experiences.

When the teacher is unresponsive to the learner's rate of progress, the learning task becomes associated with frustration, failure, and boredom. The student will eventually give up even attempting the work and become an "instructional casualty." Many students who

get labeled as learning disabled are actually instructionally disabled. The teacher can prevent such casualties by carefully gearing instruction to the phases of learning (Wolery et al., 1988).

Phases of learning. In creating a responsive learning environment to teach a new skill, we must arrange our instructional program so that it adjusts to the successive phases of learning. Initially, our concern should be on accuracy, not with how quickly or how long it takes the learner to perform the task. This phase is called the acquisition phase. In this phase, we provide any level of assistance needed to help the learner achieve accurate performance. We prompt correct answers, provide corrective feedback on inaccurate performances, model correct performances, and in other ways guide the learner toward successful performance. As performance improves, we gradually lower the level of assistance we provide until the assistance is no longer necessary (see the discussion of errorless learning above).

Once the learner performs the task consistently with a high degree of accuracy, we can advance to the fluency-building phase. Ordinarily, fluency is a descriptive term for speaking, such as being fluent in speaking a foreign language. When someone is not a fluent speaker, it is obvious. The speaker stumbles from word to word, makes many mistakes, and exhibits frequent hesitations in the flow of speech. Similarly, the student who is not fluent in, say, reading or math makes many mistakes, and the performance exhibits frequent hesitations. We can estimate fluent performance by identifying a competent learner in the particular performance. Next, we measure a sample of competent performance and use the data to set fluency criteria for the learner. We must make sure that fluency-building instruction begins only after the learner's performance is consistently accurate, however. Then we focus our instruction on increasing the rate of that learner's performance until it reaches the rate of the competent performer.

Timed practice procedures used in precision teaching are ideal for building fluent performance. As Julie Vargas (1993) related in an earlier issue of *The Teacher Educator*, "Of all the educational techniques I have read about in twenty-eight years of teaching, precision teaching has the most impressive record in improving schoolwide student performance" (p. 11). Essentially, precision teaching "is a method of tracking the rate of student performance by daily timed quizzes and special graphs based on the principles discovered by B. F. Skinner [q.v., see Lindsley, 1991]" (p. 11). Rate of performance is the essential datum of precision teaching (see response rate below). She adds that "adopting a complete precision teaching system requires training ... but even a simplified system can be very effective" (p. 12). (For further information on precision teaching, see Lindsley, 1990; West & Hamerlynck, 1992; White & Haring, 1980; and the *Journal of Precision Teaching*.)

Once the learner performs the task at the target rate, we can advance to the maintenance phase. The goal of the maintenance phase is to build an enduring performance. If we have used an external incentive system to produce fluent performance, it must be phased out systematically without loss of fluency. If, for example, reinforcers in the form of points are delivered immediately following a skilful performance, they should continue to be provided contingently but less and less often. Obviously, we must monitor the performance to make

sure it does not decline as the external support is phased out. If it does begin to weaken, we must move back to the fluency-building phase or perhaps even to the acquisition phase.

The final phase is the generalization phase. The goal of this phase is to get the skill acquired in the teaching situation to transfer to the learner's natural environment. If, for example, a child has learned to make purchases in a simulated classroom store, the next step might be to have the child purchase things in the community. The teacher would, of course, continue to monitor performance and provide appropriate feedback. What is most important about the phases of learning is that one must not advance to the next phase until the preceding phase is mastered. Ultimately, the skill should be practiced in the everyday environment of the learner.

The opposite of the responsive learning environment is rote instruction, a situation that ignores individual differences among learners and is unresponsive to the continuing performances of learners. Rote instruction is lock-step instruction, requiring all students to be on the same page (even on the same words) or on the same worksheet at the same time.

Some students will get out of phase with this lock-step approach, fall behind, and sooner or later become casualties of inappropriate instruction. We should think of these students as being instructionally disabled--something that can happen to any learner, not just the slower ones. The learner who falls behind is at risk of failing; the further behind, the greater the risk. And failure breeds more failure until learning and the school itself become a generalized punishing experience. The learner is then likely to do only minimal work to avoid the teacher's badgering.

Transforming ineffective rote instructional situations into responsive learning environments requires a thorough overhaul of the curriculum and teaching techniques based on the cybernetic functions of programmed instruction (see Vargas & Vargas, 1991). Four essential components must be in place for effective instruction to proceed, regardless of the educational setting or the characteristics of the learner: objectives, preassessment, instruction, and evaluation. An effective instructional program begins with specifications of desired learning outcomes stated in observable and measurable terms. The learning tasks are then analysed into sub objectives based on what the learner must be able to do to achieve the objectives. For example, before learners can subtract one-digit from two-digit numbers, they should be quite able to add any two single-digit numbers. In dividing tasks into their simpler components, we decide upon the size of the steps. The steps must be small enough to allow the learner to succeed but not so small that instruction becomes boring. Moderately challenging tasks motivate learners.

Once objectives have been analysed and divided into sub objectives, what is to be taught first, second, and so on is determined and organized into a systematic teaching sequence. There are no firm rules for sequencing, but generally sequencing advances from simpler to more complex tasks. The primary determining factor is learner performance. If a learner performs better on Task B after mastering Task A, then A-B is the sequence to use. The

determination is empirically made by experimenting with tasks and evaluating the results. After the proper sequence is determined, brief tests (probes) are constructed to sample performance over the various tasks, a method referred to as criterion-referenced assessment (i.e., testing what one is teaching). The resulting assessment information is then used to decide where instruction should begin.

Following the preassessment, instruction begins. Instructional strategies fall into two broad categories: manipulation of antecedent events and manipulations of Postcedent events. Antecedent manipulations can be further divided into two types, static and dynamic (or responsive). Static antecedents are conditions put into place to make the environment conducive to learning. For example, if a child appears to be easily distracted, a study carrel might be provided. Dynamic antecedent manipulations are sensitive to the continuing changes in the learner's performance. Prompting correct responses and then fading the prompts would be a dynamic antecedent manipulation. Postcedent manipulations, as the term implies, are manipulations following the learner's performance. Not all Postcedent are reinforcers, however. We must make sure that if completing academic tasks successfully is not sufficiently motivating (reinforcing), then more powerful reinforcers must be used. Perhaps allowing the student to earn free time to engage in a preferred activity would suffice as a "motivational prosthesis" for that student.

The final indispensable component for effective instruction is evaluation, the component that integrates the other components--the objectives, the preassessment, and the instructional procedures--into a cybernetic system of instruction. Because evaluation is so important in the creation of responsive learning environments, it must be given very careful consideration. When our goal is to improve instruction, standardized tests are of limited value. Direct measures are most useful (e.g., criterion-referenced assessment) to assess precisely the acquisition of the skills we are attempting to teach. To illustrate, when teaching a child to find the lowest common denominator, rather than administer a standardized achievement test, the teacher would make a test consisting of sets of such problems, then test the child's proficiency on exactly those tasks being taught. Such an evaluation is conducted frequently--ideally, each instructional day--to provide feedback to both the teacher and the learner.

Thus, in creating a responsive learning environment, rather than use some global measure (e.g., a standardized achievement test), the teacher constructs short tests (probes) to assess directly what is being taught? These evaluation data are collected frequently and used to determine whether changes need to be made in the other three components. This feedback may indicate whether we should alter the objectives, arrange the instructional tasks in a different teaching order, modify the instructional procedures, and so on. In teaching some concepts, we might experiment with the sequencing of tasks involving various positive and negative examples (see direct instruction in Kinder & Carnine, 1991; West & Hamerlynck, 1992). In other cases, perhaps a stronger prompting procedure is needed to improve the learner's performance. Or perhaps the learner is not sufficiently motivated to perform, in which case an incentive system may be needed.

What kind of evaluation data should be collected and how should it be used to improve instruction? Teachers commonly express a child's performance on a task in terms of percent correct. This practice has certain inherent limitations, however. Suppose two students achieve 90% on a math worksheet and they experienced difficulty on exactly the same kinds of problems. Can we assume that their performances are comparable? Actually not, because we do not have sufficient information. Percent scores do not account for a most important dimension of learning--time. One student might have completed the worksheet in 6 minutes whereas the other student might have taken 30 minutes--very different performances indeed! These data suggest that one student was just completing the acquisition phase while the other was well along in the fluency-building phase. Therefore, the instructional procedures we would use with these two students should differ accordingly.

The dimension of time can be incorporated into measures of performance on academic tasks by employing response rate as the measure of learning (see the discussion of precision teaching above). Response rate is determined by dividing the amount of time (usually, in minutes) a learner takes to complete an instructional task by (a) the number of correct responses and (b) the number of incorrect responses. In the example just given, suppose that both students answered 30 problems correctly. Their response rates would be 5 correct responses a minute and 1 correct response a minute respectively. When using a response rate measure for academic performance, however, it is imperative that both the correct and incorrect rates be computed. If only the correct rate is measured, we cannot determine whether the learner's performance is improving from day to day. To illustrate, if the correct rate is decreasing, but the error rate is decelerating even more, academic gains are being achieved and we should not alter the instructional procedures. Conversely, the correct rate of responding might be increasing but, if, at the same time, the incorrect response rate is increasing even more so, we would definitely want to change the instructional procedures.

When a rate measure is used, we must also make sure that the instructional tasks are comparable, that the worksheets we use as probes contain a homogeneous set of problems (technically speaking, we must calibrate the measurement). For instance, we would not want to mix story problems with other kinds of math problems on the same probe sheet. Some probes may not require any special preparation at all. For example, we might use selected passages from a first-grade reading book, take samples of problems from workbook materials, and so on.

In brief, appropriate and frequent performance measures provide feedback data that tell us whether or not the instructional procedures need to be changed and, if so, what changes to make and when to make them. Above all else, in a responsive learning environment the teacher guides the instruction according to the measured performance of the learner. If progress is not being made, the assumption of the responsive teacher is that the fault is in the instructional program, not in the learner. Applying the experimental method to instruction, the responsive teacher then proceeds to alter the instructional procedures systematically while continuing to monitor the learner's performance until success is achieved. In responsive learning environments, continuous (daily) performance measures

thus function as cybernetic systems of instruction, producing measurably superior educational outcomes.

CONCLUSION

There exists a technology of teaching based on scientifically derived principles of learning that can enable teachers to become increasingly effective in meeting the needs of learners. The principles and the derived technology come from the science of behaviorology. Yet, despite its demonstrated effectiveness and potential for improving education, few teachers are trained in this technology and proposals for restructuring schools have consistently ignored it (Kohler & Strain, 1992). Notwithstanding such pathetic neglect, I find the following from Skinner's (1968) *The Technology of Teaching* to be as cogent as ever:

No enterprise can improve itself to the fullest extent without examining its basic processes. A really effective educational system cannot be set up until we understand the processes of learning and teaching. Human behavior is far too complex to be left to casual experience or even to organized experience in the restricted environment of the classroom. Teachers need help. In particular, they need the kind of help offered by a scientific analysis of behavior. (p. 95)

AUTHOR NOTE

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