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The Advancement of Training within Business Using Behavior-Based Instructional Design

Douglas A. Johnson[a], Anita Li[b], Anna L. McCalpin[c], and Matthew M. Laske[d]

[a]Eastman Chemical Company, Kingsport, TN, USA; [b]Department of Psychology, University of Massachusetts Lowell, Lowell, MA, USA; [c]Chegg, Instructional Design and Development, Santa Clara, CA, USA; [d]University of Kansas, Department of Applied Behavioral Science, Lawrence, KS, USA

ABSTRACT

Employee training is an obvious need for business and industry. Although training has long been studied by behavioral scientists, important considerations have sometimes been neglected from the perspective of instructional design if one wants training to be both efficient and effective. The most critical outcome for the design of any training system is to efficiently ensure that the graduates from a training sequence can perform to the standards of behavior expected of an expert while facing conditions that an expert would likely encounter. As such, behavior-based instructional design places a strong focus on establishing various behavioral relations and the conditions necessary to assess trainee repertoires, which will be examined in detail. Furthermore, special consideration is necessary for design considerations with multimedia instruction, particularly within the context of computer-based training. Specializations and skills necessary for the success of a behavioral scientist working in instructional design will also be considered.

KEYWORDS
Computer-based training; employee training; instructional design; multimedia instruction; organizational behavior management

Training employees effectively and efficiently is a critical activity for organizations as subpar training can be costly to the organization and detrimental to employee performance and well-being. U.S. training costs are estimated at $92 billion dollars (Training, 2021), which does not include costs such as supplemental training efforts or onboarding new employees as a result of employee turnover due to poor training (Griffeth et al., 2000; Kazemi et al., 2015). Fournies (1978) suggested that training should be evaluated in terms of whether a supervisor would feel justified that enough evidence has been collected to comfortably assert the employee can perform a complex task. Specifically, that the supervisor would be willing to take responsibility for assigning a new worker to operate expensive and dangerous machinery, while acknowledging that errors could potentially cost millions of dollars and/or do lasting harm to others.

In an effort to reduce training time, organizations may simply give someone exposure to instructional materials (e.g., "read this") or ask them to shadow

CONTACT Douglas A. Johnson behavioranalyst@gmail.com Eastman Chemical Company, 200 South Wilcox Drive, B162, Kingsport, TN 37660, USA

someone else with more expertise (e.g., "watch them"). However, better developed practices for staff training typically follow a three-stage approach (Reid & Parsons, 2000). The first stage involves providing the trainee with instruction and modeling (though a variety of modalities, such as in-person, video-based, textual). The second stage involves having the trainee practice the instructed/modeled performance, typically under the supervision of a designated trainer. The third stage involves the trainee demonstrating some degree of proficiency to signal the conclusion of training. Multiple training approaches have formalized this basic process with varying degrees of additional nuances, including approaches such as Performance-Based Instruction (Brethower & Smalley, 1998), Model-Lead-Test (Machand-Martella et al., 2004), Behavioral Skills Training (Parsons et al., 2012), and more.

Although this basic process is fairly intuitive and successes have been documented (Marano et al., 2020; Shapiro & Kazemi, 2017), many important details are often overlooked or neglected. For the instructional and modeling phase, it is critical to minimize the amount of time that the trainee is only passively exposed to instructional material, for there is a vast literature detailing the benefits of active engagement during the learning process (Heward, 1994; Twyman & Heward, 2018; Zayac et al., 2016). Many organizations will spend excessive time in the initial stage of instructing and modeling with the assumption that the trainee is learning by watching and listening (especially when trainees nod their heads in an affirmative manner) – an assumption that can be quickly dispelled with even a simple assessment of comprehension. Large and frequently unmeasured amounts of time are probably wasted through instructional time that does little to alter the repertoire of trainees. As an alternative, steps to actively engage trainees can be simple and easily implemented, such as with teach-back procedures (Sleiman et al., 2022; Talevski et al., 2020). Instruction should also be sequenced such that there is a progressive development in complexity as behaviors get shaped or chained together. In theory, breaking the instructional sequence into appropriately sized steps should be familiar to anyone knowledgeable about shaping, but this consideration is often omitted in practice.

During the practice phase of training, feedback is frequently recommended. However, details regarding the use of feedback with newly introduced skills versus more familiar (but unmastered) skills are usually unspecified. Additional relevant feedback variables include interpersonal skills for feedback delivery, ensuring feedback is detailed enough to enable trainees to diagnose what is wrong, and building in feedback loops for both the trainee and trainer. Extensive research has been done with feedback (D. A. Johnson et al., 2022; Sleiman et al., 2020) and the reader is encouraged to consult those to evaluate their relevance for the training process. Additional variables relevant to practice include the degree of prompting as learning progresses (Machand-Martella et al., 2004).

For the phase of evaluating proficiency, it is essential that the skills are built up to fluency, not simply accuracy alone (Binder, 1996, 2022; Binder & Bloom, 1989). Fluency considers the speed of employee performance in combination with accuracy, which has implications for stability and endurance of trained skills. Fluent employee performance persists outside of training or prompted conditions. In contrast, if a trainee is simply imitating a recently demonstrated bit of feedback, such an echoic response would not ensure that performance can be done when trainer feedback is absent. Trainee performance needs to be under appropriate instructional control (such as under normal work conditions) to be considered mastered.

Trainers not only have to evaluate performance but also gauge the emotional elements of the learning process for the trainees, such as adapting the pace and demands based on subtle body language and verbal behavior indicating frustration, boredom, or impatience. Without such a consideration, emotional responding can interfere with the acquisition of skills and impact motivation to seek or continue training. Sometimes the solution can be as simple as making sure that difficult and new skills are properly interspersed with easy and familiar skills (Killeen & Nevin, 2018) and designing lean rather than bloated content to avoid redundant instruction (Brethower & Smalley, 1998; Markle, 1990). Naturally, doing this efficiently becomes more difficult as the number of learners begin to outnumber the number of instructors. In small group instruction, it may be possible to arrange it so that learners monitor and evaluate the progress of other learners under the supervision of an expert (Robbin, 2011). In larger group instruction this degree of interpersonal attention and correction may become impractical (Skinner, 1958, 1961).

Finally, the training process will be inefficient, if not completely misguided, if the knowledge, skills, and abilities targeted are not well aligned with the workplace needs for employee performance. For example, a student may be able to perfectly recite the definition for a technical term, but in practice may fail to appropriately distinguish examples of the concept from non-examples. An employee may successfully pass a multiple-choice certification about fiber optic splicing but may not be capable of splicing a fiber optic cable.

Ideally, a graduate of the training system will be able to perform as an expert performs and under the same conditions that an expert will face (Markle & Tiemann, 1970). Whether it is appropriate for a learner to consult a checklist or receive other prompts, or whether the learner needs to fluently perform without external supplements, depends on what performance standards are expected of experts. In the end, the terminal stimulus conditions for the trainee should match the stimulus conditions of the expert. The remainder of this paper will focus on the behaviors and conditions that can be taken as evidence that the appropriate contingencies have been identified and established. Just because a skill can be trained and assessed does not mean it should be trained or assessed. In order for the process of training to be both efficient and effective, it is necessary that training be well designed and in alignment with instructional design considerations.

Instructional design

Determining the best instructional stimuli for this 3-stage process, in terms of both providing direction, guidance, and assessing mastery, falls within the framework of behavior-based instructional design (D. A. Johnson, 2014, 2022). Such instructional design considerations exist for both in-person training, computer-based training, and hybrid formats and an examination of these factors will comprise the remainder of this paper. This understanding will be heavily informed by the landmark work of Susan Markle (1964, 1965, 1967, 1975, 1990), as well as more contemporary research on multimedia learning principles (Mayer, 2008; Mayer & Fiorella, 2022). A foundational assumption here is that instruction should guide learning and evoke a variety of desired overt or covert learner responses.

A typical instructional design process works backward by first identifying what the learners must be able to do upon completion of the training program or course. In other words, the designer must pinpoint the critical responses and the conditions (stimuli) that need to be present to evoke those responses, a behavior-stimulus relation. A job analysis, goal analysis, task analysis, or concept analysis, depending on nuances of the problem that the designer is striving to solve through training, is the first step to determine the target performance and corresponding behavior-stimulus relations. At this early stage in the design process, it is also necessary to ensure that the performance problem can be solved through effectively designed instruction. No matter how well designed the instruction, if the performance problem is not a deficit in competency, then the designer will not effectively improve target performance in any meaningful way.

After the designer has identified the target performance, it's essential to identify the gap between "typical" and "exemplary" performance across the learner population. According to Gilbert (2007), one approach to defining this gap is to determine the "potential for improving performance" (PIP). By defining a measurable gap in performance, it allows the designer to clearly identify the target behaviors and necessary stimuli to minimize the gap, as well as identify a valid way to measure performance changes over time. Markle (1990) also explains that there is a difference between competence (can do) and performance (does do). After defining the gap through one of the analyses listed above, the designer must determine if there is a gap in competence (people do not know how to do what they should) or a gap in performance (they can do it, but they do not have the proper antecedents or consequences).

This should include an assessment of what prerequisites are necessary for entering learners to have in their repertoire. A training solution will be less impactful if learners can already emit the behavior with stimulus control, as the solution likely lies within performance management, not instruction.

After clearly defining the target performance and current gap in that performance across the learner population, the next step is to identify the behaviors that are going to be trained through the course/program and break down the instructional materials into manageable segments information, or learning tasks, that successively build over time, ideally with feedback and differential reinforcement provided at each point of the instructional scaffolding. As part of this analysis, it is important to exclude elements of performance that cannot be physically done by the target learners and design instruction to teach only the missing performance (versus "reteaching" or exposing learners to the same instruction multiple times). From there, the designer can "backward chain" the instruction where the designer begins by pinpointing critical steps in reverse sequence, starting with the target behavior-stimulus relation, or outcome of training (Markle, 1990). This type of design approach helps segment instruction into the appropriate steps and ensures no step is missed when progressing toward the target behavior. It's important to note that while the designer progresses new steps in reverse sequence, the learner is completing steps in the correct order, with proper behavior-stimulus relations achieved upon completion of the training course or program.

As seen in Figure 1, trained behavior-stimulus relations can be organized into 10 distinct categories, with each category involving different training and assessment standards. Although these categories are organized in terms of complexity, this does not imply that every trainee starts at one end of the figure and proceeds to the other end. In some cases, more complex performances will never be needed in the workplace (e.g., some jobs involve little problem-solving and creative performances may not be desired). Due to prior learning history, the desired repertoire for more basic performance may already be at strength for some trainees. As such, the appropriate starting and ending point among these training relations will vary as learners and job demands vary. For the sake of a consistent illustration, the development of skills for an employee working at a chemical manufacturing site will be used to highlight the potential journey an employee may take among the various categories. For the sake of breadth and generalization, additional job types and performance demands will also be included.

The most basic category involves emotional learning via respondent conditioning and underlies the other categories. Within the instructional context, the various instructional stimuli are not only being used to occasion or consequate responding, but they are also being paired with other stimuli that elicit pleasant and unpleasant emotional responses. As such, the instructional context itself can eventually elicit a conditioned emotional response. For

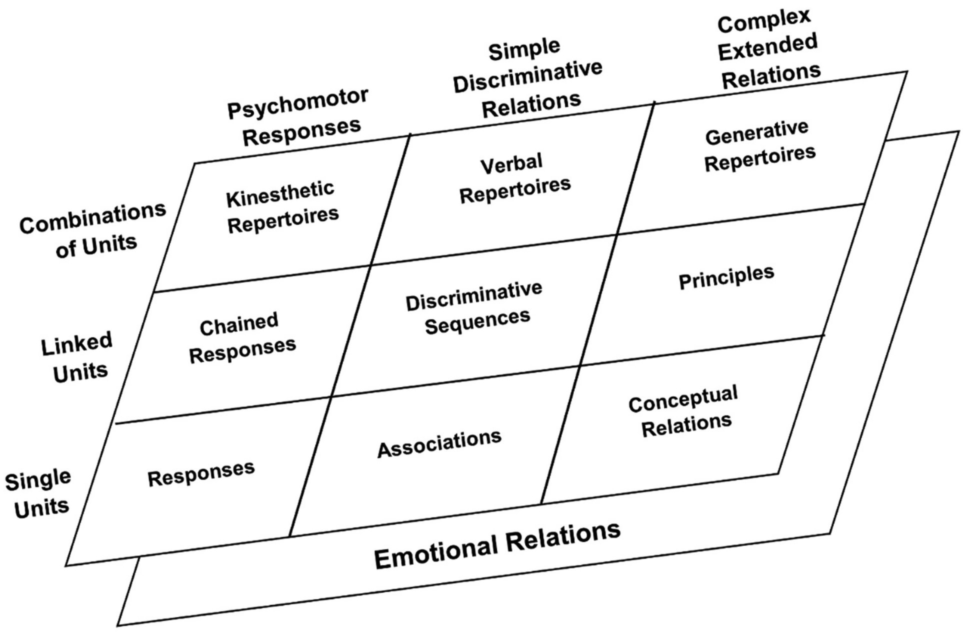

Figure 1. Types of learning. Diagram based on Tiemann and Markle (1990) and revisions by Sota et al. (2011).

example, Skinner (1954) wrote about how mathematics instruction is often poorly done, such that many learners struggle with and sometimes fail courses on such topics. As a result, mathematical stimuli begin to elicit negative emotional responses (as opposed to evoke appropriate mathematical behavior). Labels such as math phobic or math adverse may soon follow. Training contexts that are filled with tedious, frustrating, or failing experiences will soon create learners who have negative reactions to receiving instruction (or more problematic, avoid or become hostile to instructional settings). Many savvy instructors try to offset this through counterconditioning, such as bringing coffee and doughnuts to classes or workshops. Alternative approaches include integrating humorous anecdotes, storytelling, collaborative puzzles, fun exercises, and other entertaining activities to make training situations more palatable. Ultimately, the hope is for the instructional context to serve as a conditioned stimulus that elicits pleasant emotional reactions. Despite these efforts, instructional contexts may continue to elicit aversive or negative reactions due to a learner's longer history of experiencing failure as a result of ineffective instruction and training. To illustrate the importance of emotional learning, consider the perspective of someone newly hired to work at a chemical manufacturing plant. The trainee's previous jobs may have been much simpler in scope, such as working in fast food or at a grocery store. Suddenly, this person finds themselves confronted with complex products and processes as well as potentially hazardous work conditions with high stakes consequences for errors. This is likely to be intimidating for new employees and a trainer may need to be sensitive to this consideration, providing additional social support and affirmative feedback to keep the trainee on track.

Such attention to emotional variables, when not thoughtfully managed, can also be a trap for instructors. When workshop surveys and course evaluations are the only metrics of success, the instructor begins to cater to the entertainment elements of instruction and in turn these decisions are reinforced with improved audience reactions. This may be best exemplified by the classic "Dr. Fox" lectures (Naftulin et al., 1973). This research involved a series of lectures being delivered by an actor pretending to have expertise in the academic discipline he was asked to speak about. In his presentations, he told many tangential stories, relayed humorous insights, and was generally charming as he talked about subject matter he knew nothing about. Despite not sharing a single substantial comment relevant to the topic at hand, his audience still provided him with applause and a favorable evaluation. The audience failed to become more proficient in the topic, but they were pleased with the experience, nonetheless. Therefore, such emotional learning remains critically important, but it should never be the sole consideration for the successful design of instruction (see examples such as the Kirkpatrick model on how to evaluate more than just learner reactions; Kirkpatrick & Kirkpatrick, 2006). As such, we turn our attention to the other categories in Figure 1.

Starting on the left side of the figure, we can look at the column of *psychomotor responses*. For psychomotor responses, the primary consideration is whether the behavior can be successfully executed, irrespective of conditions. When the outcomes are clear for a novice, psychomotor responses can be trained through feedback from the products of responding. When the outcomes are unclear for a novice, psychomotor responses will require coaching from a proficient observer. Regardless of the feedback mechanism, ultimately control should come from the feel of muscles during fluent performance (i.e., "muscle memory" or the correct performance just "feels right"). Whether or not a psychomotor response requires explicit training will depend on the complexity of the response relative to the history of the learner. For example, most adult learners will not need instruction on how to press a button (although *when* to press the button may be a different matter). However, even for adult learners, the emittance of certain behaviors may require explicit training until it "feels natural" (e.g., positioning of wrists and arms during golf for a novice). Psychomotor responses can be broken into three different categories based on the units of behavior.

The basic "response" category involves a single unit of behavior. For example, when learning to say a foreign word or pronounce a name correctly, the focus is on a single distinct form of the vocal musculature (i.e., does it sound right?), not on whether the word is being used correctly in context. In an organizational setting, the behaviors of pressing the pedal on a forklift or how to safely position the body for lifting would fit in this category as well. When complete, the learner can immediately and accurately differentiate between correct and incorrect performance in how it feels to move the leg and foot when using the pedal or to bend down and grab an object.

The “chained responses” category involves several units of behavior being reliably linked together. For example, trainees may be asked to rehearse an entire sales script in a natural sounding manner or to complete a series of safety checks on cargo. When mastered, the trainee will be able to successfully describe their own series of behaviors as “feeling right” and their personal assessment would correspond with the evaluation of an expert.

The “kinesthetic repertoire” category involves compounds of single and linked units of behavior (again, under no particular external stimulus control). Examples of these response patterns might involve vocal training needed for a concert or the precise movements needed for surgery or flying a plane.

To return to the example of the employee hired at the chemical manufacturer, they may need practice describing the products, such as how to say methylene diphenyl diisocyanate (although we might sidestep this issue with an acronym such as MDI). Just simply saying the name correctly might be the initial focus, The employee might also need psychomotor training on how to properly wear a glove and hold a tool used for hot molding. This initial response may be expanded to holding the tool while cutting or pulling a mold. Eventually, this may be expanded even further to completing an entire product order.

The next column in Figure 1 is referred to as *simple discriminative relations*, which involves learners performing under predictable conditions. Basic discrimination training procedures are used until fluency is achieved. This can be accomplished via flashcard practice, trainer drills, examinations, essays, rehearsal with equipment, or choosing between correct and incorrect options, preferably within a realistic or actual on-the-job environment. Ultimately, the learner should be presented with a familiar stimulus that in turn immediately evokes the correct response. Established psychomotor responses first will facilitate the development of simple discriminative relations (i.e., once the learner is capable of emitting the correct response, it then becomes an exercise of getting that response to occur at the correct time), although it is not essential to progress in a sequential fashion. Paralleling the previous column, behavioral relations within this category can be further subdivided based upon the units of behavior.

For the “associations” category, a single unit of behavior is brought under generic stimulus control. For example, an employee may need to state the correct product number when presented with a familiar part. Or upon tasting a cheese, a chef may need to immediately identify the name of the cheese. Associations are rarely emitted in isolation and later require multiple or conditional discrimination once multiple associations are taught (e.g., multiple product numbers).

In the workforce, an employee may be required to emit several responses in sequence to some antecedent stimulus. For the "discriminative sequences" category, several units of behavior are linked together and under generic stimulus control. For example, a salesperson may need to say a standard paragraph upon hearing a typical customer concern. A statistician may need to execute a typical sequence of analyses by following an algorithm upon encountering a set of data.

Finally, the "verbal repertoires" category is the top row of the simple discriminative relations column. In the "verbal repertoires" category, compounds of single and linked units may be recruited under generic stimulus control. For example, a salesperson may launch into a variable sales consultation pitch upon encountering a potential client. A data analyst may describe and relate multiple data sets and figures together in a strategic planning meeting.

For a chemical manufacturing employee, after learning how to purge hydrogen from a line, the employee will need to learn the simple discriminative relation of when to purge the hydrogen from a line (e.g., when an inside operator radios in to start up the compressors). This can advance in complexity from a single unit (call on radio) to several linked units such as an exchange between inside and outside operators as displays are checked and valves are gradually opened in sequence.

For the final column of Figure 1, known as *complex extended relations*, learners must perform correctly when encountering novel and unpredictable conditions. Such relations cannot be trained using rote instruction or simple memorization, but instead require training using diverse examples and close-in nonexamples (D. A. Johnson, 2014; K. Johnson & Bulla, 2021). Minimum rational sets (which systematically present all relevant defining variables and salient irrelevant variables) made up of novel stimuli not encountered during training will be needed to assess mastery.

For the "conceptual relations" category, a single unit of behavior is brought under extended stimulus control. For someone involved in quality control, they should see brand new product and determine whether it should be categorized as "in compliance" or not. A manager may need to observe a unique client-customer interaction and determine whether it belongs in the stimulus class known as "good customer service." A talent scout may observe a new player and need to decide whether they belong in the category of "should recruit." In each of the examples, the employee is presented with an unfamiliar stimulus and must make a determination on how to categorize that stimulus. Inherently, training this type of relation involve discrimination training, but rather than repeating presenting the same S^Ds and S^Δs, groups of varying stimuli are used to establish a more complex form of stimulus control between stimulus classes (i.e., conceptual stimulus control). Mastery is judged upon successful generalization within the targeted stimulus class (novel examples) and successful discrimination between nontargeted stimulus classes (novel nonexamples).

For the "principles" category, several units of behavior may be linked together under extended stimulus control. For example, if a doctor sees a new combination of warning signs in a patient, then implementing this class of medication might treat the symptoms. Or an architect may be asked to diagnose structural risks when inspecting blueprints of a unique architecture design. Essentially, a learner must relate two or more concepts and apply these relations in novel situations and circumstances.

Successful training of principles often entails establishing several relations (IF this condition is present, THEN this will be the outcome) and then assessing via new relational scenarios. Note that concepts (e.g., reinforcer; frequency) involve a single stimulus to be responded to (e.g., "does this outcome qualify as a reinforcer?;" "is this a measure of frequency?"), unlike principles (e.g., reinforcement) that describe relations among concepts (e.g., "if behavior is followed by a reinforcer, then it will increase in frequency").

A design approach to help learners successfully establish relations within the environment where they are likely to respond is termed "context-based learning." Building context into instructional material means that learners are directly exposed to the stimuli in the actual environment where they will evoke the target response. Many times, performance can be achieved by designing the appropriate examples and non-examples and gaining appropriate stimulus control within the classroom. Other times, it may be necessary to train learners in the actual environment, with the actual stimuli, where they will be performing. This may be necessary depending on the behavior-stimulus relations that that are being trained or to gain stimulus control through the true work environment quicker. There may also be unprogrammed stimuli in the work environment that will not be formally programmed in the instructional material, yet they serve as effective behavioral prompts in the learner's environment.

For example, a student may be trained that if you withhold a reinforcer, then behavior will decrease (i.e., principle of extinction). This relational pattern should be assessed using novel examples or changing the direction of the relation. For example, if a student was trained that withholding the reinforcer of food to reduce lever pressing, the student should be tested with novel examples such as the effect of withholding attention as a reinforcer to reduce the behavior of gossiping. The original IF-THEN relation should also be reversed to a THEN-IF relation (to get an outcome of behavior reduction, what are strategies that you could use?). Note that students are often trained in the classroom using IF-THEN relations, but then in practice they need to be proficient in a variety of THEN-IF relations (e.g., "our client frequently engages in disruptive behavior, what are some options to fix it?") (Tiemann & Markle, 1990).

The final category in Figure 1 involves "generative repertoires," in which several concepts and principles are utilized under extended stimulus control. For example, when an unprecedented legal situation presents itself, an expert lawyer may need to integrate several pieces of distinct law to craft a compelling argument. Or a marketing department may need to design a new advertising campaign to capitalize upon an emerging market. Undoubtedly this higher-order learning is one of the most complex to teach as it requires a learner to apply a multitude of strategies in a novel situation outside of simple trial and error.

In regard to complex extended relations, an employee at a chemical manufacturing facility may need training on the concepts and principles involved for variables that maintain power in case none of the standard solutions fix an unexpected loss of power. Alternatively, problem solving and new ideas may be necessary when a recently constructed facility does not operate as the manufacturer specifications indicated.

Note that complex extended relations can be complicated in nature, and behavioral responses that involve extensions, blends, and derived relations often fall within these categories. Most relevant to OBM, more complex and highly valuable dependent measures such as innovation and creativity involve these forms of non-rote stimulus control. As business and industry place a greater emphasis on a creative workforce (D. A. Johnson & Akpapuna, 2018), it become incumbent upon us to understand these processes. Unfortunately, these topics tend to lend themselves to quasi-mystic explanations (e.g., "inspiration just springs from within," "I'm guided by a creative muse"), perhaps because sources of control are not readily apparent. In a recent paper, Bradley and Johnson (2021) included such ambiguity as a defining feature of creativity, when they stated that creativity involves behavior that is: a) novel (either in form or under the conditions which the response occurs) or produces a novel product, b) valued by a social community, and c) produced by variables that are not salient to that social community. Although OBM has a long and successful history using conventional dependent measures such as productivity or satisfaction, our future will likely necessitate a broader array of dependent measures such as novelty or creativity. The behavioral-based instructional design considerations outlined above can provide a framework for generating new training and assessment solutions. These considerations apply to both newly hired and existing employees. Where in the sequence one starts depends upon a) the existing repertoire of the trainee and b) the ultimate responses needed for successful performance in the ongoing work environment. For example, the ability to manipulate a tool or piece of equipment may require much initial attention at the level of psychomotor responses for a new employee but be irrelevant for a more experienced employee. As proficiency is developed by the new employee, the focus may shift from *how* to *when* to execute performance (i.e., shift from psychomotor responses to simple discriminative relations). A more seasoned employee may also find themselves in need of psychomotor training if new tools or equipment are purchased, but training on simple discriminative relations may still remain unnecessary. For example, if new emergency respirators are purchased, an experienced employee may need training on proper operation of the respirator, but the stimulus conditions for when to put on the respirators remain the same (e.g., flashing alarms about hazardous vapors are unchanged). The previously mentioned categories are meant to guide instructional designers and trainers as they try to determine whether training solutions will correctly establish the appropriate behaviors under the appropriate conditions. These stimulus-behavior relations are important to examine whether training is in-person, remote, computer-based, or some combination of these modalities.

Computer-based training

Much of the history of instructional design and training has involved direct face-to-face training interventions. However, as technology develops, computer-based training solutions have grown more prominent (D. A. Johnson & Rubin, 2011) as it provides organizations streamlined and consistent training and forgoes the consistent need for expert and available trainers. As such, it is imperative that trainers are also well versed in newly introduced technologies to avoid detrimental effects (Haepp, 2021). It requires special consideration from an instructional design perspective as there are a variety of multimedia and technology that can be incorporated in trainer-led or learner-led modules. Computer-based instruction is not simply a change of modality in training materials. The benefits and detriments of computer-based training are also worth considering, for violating multimedia principles can inhibit the establishment of the stimulus-behavior relations described in the previous section.

In some ways, computer-based training shares a connection with the original attempts of behavior analysis to solve socially significant applications. Although B. F. Skinner eventually became the person most synonymous with a comprehensive understanding of behavior technology, he dedicated much of his early career trying to pinpoint functional relations through carefully controlled laboratory conditions (D. A. Johnson, 2014, 2022). Although he could imagine eventual widespread applications of a behavioral science (Skinner, 1948, 1953), he spent his time doing basic experimental work with laboratory animals (Ferster & Skinner, 1957; Skinner, 1938). However, after witnessing educational lessons during a visit to his daughter's classroom and noting the disparity between the careful precision with which he trained pigeons and the needless inefficiencies with the education of children, he felt like more immediate applications were called for, even if the science was not yet fully mature (Skinner, 1983).

Skinner's analysis of education found that the primary fault lay with the fact that no teacher, no matter how well-intended or hard-working, could effectively and efficiently manage the number of contingencies required to teach a large number of students simultaneously (Skinner, 1958). It may be worth noting that despite the passage of over 60 years since Skinner's original analysis, modern education has sadly not appreciably advanced in terms of how the contingencies are managed (e.g., large group instruction, control that is primarily aversive in nature, a lack of systematic planning across topics and curriculum, infrequent and delayed use of reinforcement, vague outcomes that are not precisely aligned with the receiving systems). That includes whether we are discussing K–12 or higher education. In short, we need large numbers of well-educated people, but our systems are not properly designed to meet this need. As Skinner pointed out, the history of societal innovations has shown the mass production problems are typically solved through automation. Skinner designed teaching machines that could automate the more routine aspects of education (e.g., content delivery, evaluation of simple and rote responses), freeing up teachers to address the more nuanced aspects (e.g., interpersonal relations, social reinforcement, evaluation of more complex responses). By pairing a single student with a teaching machine (as opposed to several students to one teacher), instruction could be individualized and self-paced. Interactions with feedback could occur rapidly in the same manner as a tutor-pupil relation. A single educational lesson could be widely distributed and frequently reused.

Although Skinner's teaching machine were never widely implemented, despite successful pilot data, the advantages of yesterday's teaching machines directly parallel today's computer-based training. Computer-based training not only permits self-paced, interactive, and individualized instruction, but modern communication allows distribution to be global and immediate. Such remote features are particularly noteworthy during times when public health concerns or global business practices disrupt traditional instructional modalities. Furthermore, multimedia capabilities allow video demonstrations, recording of student performance, and live components to supplement the basic content.

Another cited challenge of computer-based learning is the presence of competing activities with more reinforcing value to the learner at the time of instruction. The presence of these competing activities may result in learners moving too quickly (racing) through the instruction so that they can move on to a more reinforcing set of conditions. Or, if training is not a requirement for the learner, it may lead to complete avoidance of the instruction altogether. In those cases where learners move quickly to escape the learning environment, responding may be too rapid for actual learning to occur, which has been termed computer-based racing (D. A. Johnson & Dickinson, 2012). Computer-based racing will continue to be a problem in online learning if designers do not promote approaching and orienting behaviors through the instruction (Marroletti & Johnson, 2014). As previously mentioned, one of the most basic types of learning relations is emotional learning (Markle, 1990). To promote approaching behaviors, the designer can pair the instructional material with other stimuli that are likely to elicit a positive emotional response.

Another approach to minimizing avoidance or escape behavior amongst learners is to program the online learning in a way that reduces computer-based racing, like the inclusion of post-feedback delays where, after presenting feedback on the learner's response, the instructional program enforces a delay for a predetermined amount of time before the learner can continue through the material (Crosbie & Kelly, 1994; Dubuque, 2012; D. A. Johnson & Dickinson, 2012).

Computer-based training is not a magical panacea, and the disadvantages should not be neglected or ignored. Computer-based training focuses on a modality but inherent within is the importance of thoughtful design and execution. Effective computer-based training requires a significant upfront investment in development, which makes it a poor solution for small-scale training, especially if there will be limited usage over time (e.g., small number of employees, infrequent turnover). If the content to be delivered is rapidly changing (e.g., cutting edge innovations, areas of future updates from research), then computer-based training may not be able to keep up such subject matter advancements. When the student response products are particularly lengthy, subtle, or nuanced, evaluation of those responses may be beyond the capabilities of modern programming (e.g., writing a dissertation, completing a full negotiation with a prospective consumer). Finally, computer-based training necessitates instructional designers well-versed in multimedia principles that are integral to their success. If computer-based training is determined to be a well-suited solution, then a brief review of some of the most relevant design principles would be advised and a brief summary follows.

Multimedia principles

Multimedia principles are typically derived from cognitive theories of learning, but behavior analysts should not eschew these findings simply based on theoretical differences. Multimedia principles are typically derived from user research by assessing modality and aspects of multimedia features and how they affect learner's understanding. One rationale for labeling these as multimedia principles, rather than computer-based instruction principles, is that they can apply to any modality. However, they are being highlighted in this particular context due to the frequency with which these principles are violated during the development of computer-based instructional solutions. As such, we will present relevant multimedia principles and also relate them within a behavioral conceptual system.

One such principle is the coherence principle, which states that instruction needs to focus on essential material only and any extraneous material should be eliminated (Harp & Mayer, 1998; Mayer et al., 1996). This notion of "trimming the fat" is hardly new or unique to computer-based instruction (indeed, many behavior-based instructional designers have emphasized the point – see Brethower & Smalley, 1998; D. A. Johnson, 2022; Tiemann & Markle, 1990; Vargas, 2009). However, it seems worth stressing with computer-based instruction, due to the attractive capabilities of programming, have often led designers to include features and materials simply because they can (such as the inclusion of rich media like audio, graphics, and text). The cognitive assumption is that such presence of additional stimuli overloads the learner's working memory (Mayer & Fiorella, 2022). Another interpretation is that the additional of supplemental stimuli competes with the critical stimuli meant to evoke learner responses. Therefore, by eliminating superfluous stimuli, it results in increased saliency of the relevant features of the critical stimuli at hand.

The signaling principle refers to the addition of cues to highlight the most relevant features of instruction and to organize the material (Lorch Jr., Lorch, 1989; Mayer & Fiorella, 2022). Figure 2 gives an example of how the signaling principle might be implemented to orient the trainee. The addition of prompts also has a long history in behavior analysis in the forms of prompts, errorless learning, etc., but often is not addressed within the context of computer-based instruction. Note that such prompts can take many forms, such as the use of arrows, highlighting text or parts of an illustration, modifying fonts, and more.

Figure 2. Signaling principle example. Photo by Adrian Sulyok on Unsplash.

The redundancy principle suggests that the addition of redundant information will inhibit rather than facilitate learning (Kalyuga & Sweller, 2022). The most common violation of this within computer-based instruction is the addition of on-screen text when spoken text alone will suffice. It may be tempting to eliminate spoken narration to ensure that on-screen text is never redundant but spoken text can have benefits. For example, when illustrations or diagrams need to be presented, on-screen text will hinder learning since two competing incompatible responses will be required at once (i.e., one cannot look at text and a figure at the same time, but one can listen to narration and look at a figure simultaneously). However, the redundancy principle has some qualifications to it. For example, if an instance of text is particularly lengthy, then a visual presentation may be preferable to auditory presentation since the reading speed of most learners will exceed the speaking rate of most narrators. If a passage of text is particularly complex or difficult to follow, on-screen text may be preferable due to a need for repetition and the ephemeral nature of the spoken word. Spoken narration may prove less effective if the learner has difficulty understanding it (e.g., spoken words in a less familiar accent or language). Although this principle suggests steps to maximize performance for the average learners, it is essential to design instruction that can be utilized by all learners. For example, it may be generally beneficial to develop instruction to eliminate written text in favor of spoken text by default, options should still exist to enable written text if necessary (e.g., learners unable to hear spoken text such as those without audio outputs or Deaf and hearing impaired people).

The spatial contiguity principle states that training will work better when on-screen text and the relevant visuals are physically close to one another (Mayer & Fiorella, 2022). Figure 3 provides an example of how a segment

Figure 3. Spatial contiguity principle example. The figure on the left is a non-example of the spatial principle. The figure on the right is an example of the spatial principle. Photo by Adrian Sulyok on Unsplash.

Table 1. Multimedia principles.

Principle	Definition	Example
Signaling	Additional cues are added to highlight the most relevant instructional materials	• Arrows pointing to relevant stimuli • Text/image highlights • Changing stimulus size
Redundancy	Additional information that is redundant inhibits learning	• On screen text that is redundant with the information in a figure
Spatial contiguity	On screen text and accompanying visual should be presented close to one another	• On screen text embedded in an • image next to the relevant features of the image
Temporal contiguity	On screen text is presented at the same time as the accompanying visual	• On screen text included on the same • screen as the accompanying visual
Social presence	Additional stimuli should mimic interactions with another social being	• Material is more conversational than formal • Vocal verbal instruction is delivered in a human voice rather than machine

of instruction could be reworked in accordance with this principle. Similar in logic, but involving the dimension of time rather than space, the temporal contiguity principles states that training will work better when on-screen text is presented at the same time as the relevant visuals, as opposed to consecutive presentations (e.g., "as you can see on the figure at the beginning of the chapter … "). The elimination of delay between stimuli facilitates learning whereas sequential presentations may interrupt the flow of instruction.

The final design consideration when developing computer-based training solutions is social presence. The key theme of social presence is that training will be more effective if it evokes feelings of interacting with another social being. Social presence can further be reduced into personalization, voice, image, and embodiment principles. The personalization principle suggests that trainees will learn more effectively when the words used in training are conversational rather than formal (e.g., "your objective in this task … " vs. "the objective in this task … "). In comparing vocal verbal delivery of material, the voice principle states that human voice is more effective than machine voice. The personalization and voice principle likely relate to pleasant emotional learning experiences via casual (rather than formal) modes of delivery and human interaction.

When considering the adoption of a computer-based training the instructional designer must consider these multimedia principles (see Table 1 for a summary). With technological advances and new software becoming available regularly, it can be tempting for the trainer to add additional "bells and whistles" to their training. As previously suggested, entertaining elements alone are not sufficient for effective training design and can even be detrimental to training outcomes. It is imperative that training developers do not fall for such seductive details. As Ogden Lindsley (1992) once put it, our society needs learning, but we want and pay for entertainment. In general, every stimulus added to the training should be carefully scrutinized based on these principles (and the rest of the considerations from this paper) to ensure they enhance rather than diminish training.

Conclusion

In order to accomplish the mission of using behavior-based instruction design to support better training practices, any instructional designer needs to be well-versed in several skillsets to navigate the complexities of modern business. Trained behaviors need to align with workplace accomplishments that will improve the well-being of the employees and provide the necessary return on the organization's investment. This necessitates thoughtful collaborations and partnerships with leadership, subject matter experts, and those responsible for implementation of directives. This will have to take place across many conversations and multiple attempts to understand the concerns of the relevant parties, often including the unstated contingencies that may be at play. Maintenance of trained repertoires will require ongoing support, which may necessitate training boosters, re-assessments of skills, planned rotations in job responsibilities so that newly established repertoires are not neglected, factoring trained behaviors into overall performance appraisals, and more. In short, trained skills may be lost or displaced over time if not utilized, so counteractive strategies are necessary. Many forms of continuing education exist with this consideration in mind, although it is important that follow-up training and assessments are in-depth and not a quick and meaningless checkbox being checked off. Feedback and incentive structures may need to be aligned to support the acquisition of important skills. In short, a savvy training leader cannot be knowledgeable about the contingencies related to learning alone but needs to understand and align contingencies of key personnel throughout the workplace. Successful instructional design requires the awareness of, adaptation to, and sometimes the influence of the broader work context, which in turn requires the implementation of many behavioral tools found within organizational behavior management. The risk of designing a training system that does not fit within the broader organizational system is that instructional innovations may be short lived, ignored, or resisted. In order for instructional design solutions to be meaningfully adopted, any behavioral scientist should invest significant time into continually training themselves on a breadth of behavioral tools so that they can then successfully guide the training of others.

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ORCID

Matthew M. Laske http://orcid.org/0000-0003-0195-5186

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