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# Designing Courseware: Prompts from Behavioral Instruction

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**Behavior analysis has been at the forefront of instructional design for many years. However, this leadership position is rapidly eroding as teachers, trainers and other educators insist that behavioral instruction is good only for meeting simplistic educational goals. I argue that in order for behavior analysis to continue to influence the field of instructional design, behavior analysts need to help people develop instructional programs that use advanced interactive computer systems and that are based on all the components of behavioral instruction. Therefore, this paper suggests the following strategy. First, it teaches people to select authoring systems that will enable them to design interactive computer programs. Second, in order to improve current authoring systems it provides a set of prompts that integrate the features of behavioral instruction. I claim that the integration of these prompts with an advanced authoring system will facilitate the development of complex, conceptual learning programs and minimize current criticisms of behavioral instruction.**

Although behavioral research has stimulated much instructional innovation and educational technology (Becker & Engelmann, 1978; Gagné, 1965; Glaser, 1962; Keller, 1968; Lindsley, 1964; Mager, 1962, 1972; Skinner, 1968; White & Haring, 1980), teachers, trainers, personnel directors and others continue to claim that instructional strategies from a behavioral perspective are not sufficient to solve many educational problems (Royer, 1979; Schuster, 1984). Though there are many kinds of negative reactions to behavioral instruction, two reactions seem to surface all too often among educators and trainers. First, the critics claim that the instructional programs created by behavior analysts do not take advantage of the advances that have been made in educational technology, specifically the use of computers, computer-video interactions, and other hardware that provide opportunity for interactive, realistic educational applications. Second, they claim that the instructional programs created by behavior analysts concentrate on low level skills and ignore complex, conceptual behavior. In order to counter these criticisms, it might behoove behavior analysts to demonstrate how the principles of behavior can be applied to the design of complex, conceptual learning programs developed for use with advanced computer and other interactive systems.

This paper attempts a first step toward countering many of the problems raised by these criticisms of behavioral instruction. Behavior principles can be applied to the development of complex, computer-assisted learning programs if two strategies for creating instructional programs are adopted. First, program designers should select and use authoring systems for computer assisted instructional materials. Second, designers should make sure that their programs are based on the principles of behavior. The purpose of this paper, therefore, is to introduce a general integration of these two strategies. This purpose will be accomplished by a brief analysis of the skills needed to program instructional materials, an analysis of the questions to ask when selecting authoring systems, and a set of prompts derived from principles of behavior for designing complex, conceptual instructional programs.

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## THREE KINDS OF EXPERTISE

Scandura (1981) suggested that three kinds of skills are necessary to develop instructional materials for application on computers (i.e., courseware). First, one must be a content expert. This assumption seems reasonable. For example, if one wants to teach people how to write memos that communicate clearly, concisely, and sensitively, one needs to know how memos should be written. Second, one must be a computer expert. Computers have obvious technological features that baffle many. If one wishes to program a computer to teach, one had better be able to operate the computer to do so. Operating a computer involves a variety of skills. Moreover, programming instructional materials requires fairly sophisticated skills, especially if one wishes to use the more advanced technologies such as interactive video systems. Third, one must be an instructional designer or educational expert. Sound instructional design involves many components, and if one wants to develop an educational package that teaches students successfully, then being an expert on how to organize, present, and evaluate the components of the instructional materials would be of great assistance.

Obviously, such an integration of skills is rare. Many people believe they are experts in two of these areas, but very few individuals engage in all three types of skills accurately and fluently. Given the skills needed to develop courseware, it is hardly surprising that available software is not very effective (Gagné, Wager, & Rajas, 1981; Otte, 1984).

This conclusion leads to a question: How can all three kinds of expertise be synthesized to assure the development of effective courseware? The answer, I believe, depends on the skills that an individual already exhibits. If individuals do not have expertise in the content to be programmed, then they should find a content expert to assist them. If an individual has some content expertise, but has either little experience in programming computers or applying the principles of behavior to the design of instructional materials, then the following should be helpful.

## AUTHORING SYSTEMS

A number of people have suggested that authoring systems might effectively assist teachers and others develop software. An authoring system is a program or a set of programs that allows an instructor or instructional designer to create courseware without having to program the computer (Kearsley, 1982). Although many kinds of authoring systems are available (Kearsley, 1982), the following discussion is restricted to "prompted" authoring systems because of their effectiveness for the problems under consideration.

Imagine that we are interested in developing a computer program to teach students about reinforcement theory. We gather around our computer terminal, plug a floppy disk labelled "authoring system" into one disk drive and a blank disk into the other. Immediately, the authoring system begins to ask us questions. This is the prompting feature of this authoring system. It will ask us to provide information about reinforcement that we believe is necessary to teach our students, and will ask us to make decisions about the text or video materials to be programmed, as well as the kinds of questions, graphics, sound effects, and consequences that might be included in the program. In short, it will ask us to decide on the content and the structure of the program. The second feature of the authoring system is the coding of the program content into a computer language so that the computer can use the information efficiently. The system's third feature is to access the coded content and present the content as curriculum to the students. A possible fourth feature is to collect data on student performance, progress through the program, and other information that might be useful. Authoring systems make the use of computers by nonprogrammers easier and less time consuming by taking care of the computer expertise and some features of instructional design, while the authors take care of the content.

Although a number of authoring systems have been developed in accordance with this general formula, reviews of authoring systems and the literature on these systems indicate a number of problems (Kearsley, 1982; Scandura, 1981). One problem is the number and variety of authoring systems that are available. The easiest way to circumvent this problem is to select a system that takes care of as many computer problems as needed by an individual author, that programs the kinds of tasks the author wishes to program, and that collects the most useful kinds of data for particular applications. Authors might use criteria similar to those recommended for selecting ready-made courseware (Lewis, 1984; Zemke, 1984). Table 1 lists some questions that the author might ask when evaluating authoring systems. Answers to these questions should easily narrow down the possible systems that will be useful.

Perhaps the most glaring problem with authoring systems, however, is that the prompting systems for promoting sound instructional design are either nonexistent or not thorough enough with respect to principles of behavior to control the behavior of the authors. In order to circumvent this problem, authors can be provided with prompts outside of the authoring system that foster better instructional design. This is particularly helpful for authors who have had little experience applying the principles of behavior to the design of instructional materials. The second part of this paper addresses this problem by describing an integration of instructional design principles, and by providing the features of effective instructional design in terms of a series of prompts.

## ESTABLISHED FEATURES OF INSTRUCTIONAL DESIGN

Many features of a sound instructional design have already been studied and specified. One often-cited model that integrates these features concentrates on a sequence of tasks that the teacher performs throughout the development of instructional materials (Glaser, 1962).

**TABLE 1**

**Questions to ask when evaluating authoring systems[a]**

1. Does the authoring system work on your computer equipment?
2. Does the authoring system document the success that authors have had using it?
   - Do authors find it easy to use?
   - Do authors report that it decreases program development time?
3. Is the authoring system flexible enough to allow you to use it for all the uses you envision?
   - Do you want to create drill and practice programs?
   - Do you want to create tutorial programs?
   - Do you want to create simulations with video or graphic sequences?
   - Do you want to create games?
   - Do you want to ask multiple-choice, true-false, matching, and/or constructed response questions?
4. Does the authoring system collect all the kinds of data you wish to collect?
   - Does it collect time data for each student response?
   - Does it summarize the time data over all the responses by the student?
   - Does it collect correct and incorrect response data?
   - Does it summarize correct and incorrect data in terms of accuracy ratios?
   - Does it collect or report frequency data, the ratio of correct, and incorrect responses over time?
5. Does the authoring system take advantage of the computer's interactive capabilities?
   - Does it allow students to respond in a variety of ways?
   - Does it allow you to program feedback, help and explanations?
   - Can students change their answers before the computer records and evaluates the answer?
6. Are the mechanics of the system clear?
   - Can you sit down and make the system work?
   - Do you know where you are in the program at all times?
   - Do you know how to exit at all times?
   - Can you easily reenter the program after exiting?
   - Can you backup in the program?
   - Do screen displays look good to you?
   - Are there spelling errors, grammatical errors or other obvious errors that will bother you?

[a] Adapted from Zemke (1984).

These tasks can be listed simply: specify the goals, objectives, and tasks for the students; assess the entering behavior and general learning skills of the students (e.g., vocabulary level and reading proficiency); write the program; evaluate the program; revise the program; and reevaluate (Anderson & Faust, 1973; Glaser, 1962; Royer & Feldman, 1984). This model is typically called a systems model because it describes the interaction of a number of components of an instructional system. It is a system based on behavioristic research and development (Royer & Feldman, 1984); however, the system can be consistent with models other than behavior analysis. Therein lies one of the primary problems of such a simple specification of teacher behaviors: the components do not necessarily adhere to any one model and, in fact, specific instances of using the model can be inconsistent with a particular model.

In order to make this systems model more explicitly behavior analytic, several features may be added. The steps of the systems model might best be divided into three general categories of behavior for the educator: 1) a logical analysis of what the educator would like to teach, 2) a logical analysis of how the educator is going to teach, and 3) an experimental analysis of student interactions with the instructional materials. Obviously, these components are interactive, but it might help to separate them this way as a heuristic. Other models have used similar heuristics. For example, a closely related model has been described by Engelmann and Carnine (1982). This model is divided into three components also: 1) an analysis of the learner's behavior, 2) an analysis of the stimuli with which the learner interacts, and 3) an analysis of how to organize the content of instruction. The analysis presented here is indebted to Englemann's theoretical work (e.g., Englemann, 1969), particularly in the area of logically analyzing the content of instruction. However, Englemann and Carnine's (1982) model is not synonymous with that presented here. The present model is particularly different in its method for selecting the kinds of behaviors that an instructional system will teach. This selection process is described as the first component of the model: a logical analysis of what to teach.

*Analyzing What to Teach*

The first category of the instructional model subsumes the first three steps of the systems model—specifying the goals, objectives, and tasks for the student, as well as integrating all of the features of the instructional model. That is, often the first step in planning instruction is to explicate the general to specific goals. The justification for goal analysis can be obtained from various works on systems analysis and related fields (Churchman, 1968; Gilbert, 1978; Mager, 1962, 1972), thus I will not discuss these issues. What I would like to discuss is how a functional classification system that is consistent with operant theory helps to specify instructional goals, objectives, and tasks, and how this classification system can help emphasize complex, conceptual behavior.

Skinner (1957) specified the requirements for a functional account of verbal behavior. Those requirements can be described simply: The system must be functionally descriptive, and must precisely define the different responses, relations among the responses, and all aspects of the social and physical environment. Skinner's classification scheme adhered to these requirements for verbal behavior in general (Skinner, 1957).

Johnson and Chase (1981) designed a typology of verbal instructional tasks that adheres to the functional requirements of Skinner's analysis. The system is functionally descriptive and accounts for the multiple, observable, controlling variables operating on an individual's verbal behavior within an instructional environment. The typology should guide the teacher to design materials that range across a variety of different *classes* or *types* of verbal behavior, each with its own controlling relations. In this respect, the functional typology is similar to the classification schemes that have been developed by other educators (cf. Bloom et

**TABLE 2[a]**

**Questions to answer when deciding on the types of verbal skills student should perform**

| Do you want the student to . . . | If so, program . . . | Examples . . . |
|---|---|---|
| 1. say something exactly as you say it? | 1. echoic tasks | 1. Correctly repeat the following lines from *Hamlet*. Copy my intonation. |
| 2. say something exactly as you wrote it? | 2. textual tasks | 2. Please read and pronounce correctly the following medical terms. |
| 3. write something exactly as you wrote it? | 3. copy tasks | 3. Correctly copy the following Chinese characters. |
| 4. write something exactly as you say it? | 4. dictation tasks | 4. Correctly spell the following terms for the lab equipment as I say them. |
| 5. ask for something needed to complete a task? | 5. mand tasks | 5. At some point in this task you will not be able to proceed without asking me for help; your job is to ask the right question so that you can complete the project. |
| 6. define general rules or general features that define a term, topic or concept, without access to the rules or features? | 6. definition tasks (intraverbal) | 6. Define reinforcement without looking at your notes. Compare and contrast discriminative stimuli and establishing stimuli. |
| 7. identify descriptions of specific instances of a topic or phenomenon? | 7. example identification tasks (intraverbal) | 7. Say which of the following scenarios is an example of positive reinforcement. |
| 8. state original examples of a phenomenon? (originality) | 8. exemplification tasks (intraverbal) | 8. Give an original example of reinforcement. Write an original poem using iambic pentameter. |
| 9. describe the specific characteristics of environmental events as they occur? | 9. example component analysis (tact) | 9. Identify at least three distinctive features of each of the wines in the goblets in front of you. |
| 10. specify a term or label that can be used to categorize a group of environmental events. | 10. example identification tasks (tact) | 10. Say whether each of the following videotape sceanrios illustrates assertive or aggressive behaviors. |
| 11. combine any two or more of the above tasks. | 11. combination tasks | 11. Describe what general principle Skinner refers to on pg. 61 and give an example of this principle from your experience. |

[a] Adapted from Johnson and Chase (1981).

al., 1956; Gagné, 1965; Williams, 1977). These educators assumed that analyzing instructional tasks into different classes assists the teacher in specifying the goals, objectives, and tasks of instruction, and thereby allows the teacher greater control over the type of instruction that will transpire.

Table 2 presents a set of questions or prompts that have been adopted from the functional typology described by Johnson and Chase (1981). These questions can be used by teachers for developing courseware and for selecting authoring systems. Answering such questions might assist teachers in determining the range of goals, objectives, and tasks that they might wish to include in their programs, whether these goals are appropriate for a computer-assisted format and whether there are authoring systems available for programming such instruction.

I should note a few critical differences between the classification system proposed by Johnson and Chase (1981) and others. It is these differences that assist teachers in describing goals, objectives, and tasks in behavior analytic terms. One critical difference is that *complex* verbal behavior is defined as learning a variety of verbal responses. Instructional objectives should be modeled on the verbal behavior of professionals. What epitomizes the verbal behavior of professionals is the wide variety of ways that they can discuss the content of a discipline. Thus, they make relations between seemingly unrelated content, give examples that illustrate the key features of concepts, and solve problems that require memorization of facts, recall of complex relations, and identification and discrimination of physical aspects of the world.

The second distinguishing feature of this functional classification system is that it establishes a continuum of tasks from elementary relations to conceptual relations. Elementary relations are rigid and inflexible, and do not involve novelty. Thus, a memorized fact that is emitted only when a specific question is asked would be an elementary relation. Conceptual relations are those that are extended to new situations or instances. Conceptual relations are flexible; the behavior occurs in the presence of different, novel instances of the stimuli. For example, an individual would be engaging in conceptual behavior if horned-rimmed, metal-rimmed, pince-nez, monocles, as well as bright red, rhinestone-studded spectacles all occasioned the response, eyeglasses. Similarly, comparing and contrasting liberalism and conservatism when a text and teacher had not compared and contrasted them would be an example of conceptual behavior. In other words, conceptual relations involve extension or generalization within a stimulus class as well as discrimination between stimulus classes (Keller & Schoenfeld, 1950; Becker, Engelmann, & Thomas, 1975). If this definition of conceptual behavior is integrated with the definition of complex behavior, an operational definition of *complex, conceptual behavior* emerges: When a student engages in many different classes of verbal behavior in the presence of novel instances of physical, social; and verbal stimulus classes, and does not engage in those behaviors in the presence of other stimulus classes.

Other features of Johnson and Chase's (1981) functional typology distinguish it from other classification schemes for instructional goals. Let it suffice to say here that the functional classification system is based on observed functional relations between student and teacher behavior. Other classification systems are based on structural and/or unobservable characteristics. A functional typology of instructional tasks adheres to both of Skinner's requirements (Skinner, 1957) and helps maintain a behavior analytic perspective on the selection of goals, objectives, and tasks.

In addition to a complete analysis of verbal skills, planning what to teach requires analyzing the topics to be taught. We do not just say we are going to teach verbal skills. Rather, we say we are going to teach verbal skills concerning introductory psychology or industrial relations or some other topic (Englemann & Carnine, 1982). In order to determine the specific topics, one should conduct a fine-grained analysis of the subject matter.

As a brief aside, I will mention that analyzing the topics of instruction is typically referred to as concept analysis. The behavior analytic definition of a concept, however, differs slightly from other formulations. In behavior analytic terms, a concept is best described in terms of conceptual behavior (Keller & Schoenfeld, 1950). As stated above, conceptual behavior differs from other behaviors in that individuals respond in a similar fashion to a definable class of environmental events. A definable class of environmental events includes all instances or examples that share some critical, similar characteristics. The individual must engage in similar behavior in the presence of instances that include the similar characteristics (generalization) and not engage in this behavior in the presence of instances that do not share similar features (discrimination). Thus, the emphasis in a behavior analytic definition is placed on the relation between the particular environmental instances and the particular behavior.

The operant emphasis reveals a general to specific organization of conceptual behavior. For instance, we might start with a general statement that we want students to engage in verbal behavior about reinforcement. This is a general class of conceptual behavior. We become more specific when we say that we want students to identify examples of reinforcement or we want students to define reinforcement under various circumstances. These two concepts are different from each other and each has a separate organization of related subordinate concepts (e.g., identifying consequences versus defining consequences, and defining increments in behavior versus identifying increments in behavior). Thus, in order to plan instruction, a typology of verbal skills is matched with the typology of environmental events that comprise such general concepts as reinforcement. This latter analysis I refer to as a topic analysis (i.e., developing a classification scheme for each topic or general concept).

In order to complete a fine-grained topic analysis teachers can start with a general definition of the topics that they want to teach. This definition should include all the critical components of the topic, should either agree with standard references or justify why it does not conform to such standards, and should be stated in clear, concise, operational language that overlaps with the expected verbal skills of the student audience. This type of definition should reveal at least the first level of subtopics that may be prerequisites to learning the topic of interest.

For example, if we wish to program a lesson to teach the principles of behavior, we might start with the topic of positive reinforcement. We define it as the presentation of a consequence that increases or maintains the strength (e.g., rate, duration, intensity) of the response. From this definition, we know that the student has to verbalize what consequences and increments are and how they are determined. We also check Catania (1968) and Sulzer-Azaroff and Mayer (1977) to see that our definition conforms to these standard references.

Once the topic is defined, teachers can define each subtopic by using the same criteria that were used for the general topic. For the reinforcement example, we find that other subtopics are revealed such as "environmental event" and "measurement." These, too, should be defined. We continue this process in as much detail as is logistically possible until we eventually end up with a diagram of reinforcement and its components. Table 3 presents a check list of this process that may be useful for those developing instructional programs. If program developers ask these questions of themselves while designing courseware they might be more likely to develop courseware that is sequenced in an order that produces effective learning.

In addition to this kind of analysis of the components of a selected topic, I also recommend listing and analyzing topics that may be related to the original topic. Although there are few standard methods for doing this, determining other topics that share characteristics of the original topic or that appear either temporally or spacially with the original topic may be worthwhile. For the reinforcement example, punishment shares the property of presenting or terminating a consequence, negative reinforcement shares the characteristic of an observed increase in behavior, stimulus control is a topic that often occurs along with reinforcement, and so forth. Thus, we would analyze these topics as well to form an even more complete diagram of related topics and their components. Table 3 presents the questions that one might ask to conduct this part of the analysis. For further descriptions of the process of organizing the topics for instruction, the reader might read chapters 10, 11, and 12 in Engelmann and Carnine (1982).

Once one has analyzed a set of topics in this fashion, then the topics can be

**TABLE 3**

**Checklist for conducting a topical analysis**

| | |
|---|---|
| ____ | 1. Give your program a topic name (e.g., reinforcement). |
| ____ | 2. Is your name descriptive, discriminable from other topics, and consistent with standard references? If no, rename or justify it. If yes, go to 3. |
| ____ | 3. Outline the general characteristics of your topic. This includes related topics, defining properties, and any term that you associate with your topic. |
| ____ | 4. Examine each characteristic. Is it critical to the topic or is it present whenever the topic is present? If no, set aside in a file on related topics or properties. If yes, go to 5. |
| ____ | 5. List each characteristic as a critical property of the topic. |
| ____ | 6. Is each property descriptive, discriminable from others, and consistent with standard references? If no, rename or justify. If yes, go to 7. |
| ____ | 7. Have you analyzed the topic into properties that your students already "know" (can identify, can define, can exemplify, etc.)? If no, go to 3 and analyze each property as you did your topic. If yes, go to 8. |
| ____ | 8. Examine each related topic and property in your file. Do you wish to include it in this program?[a] If no, stop. If yes, go to 3 and analyze each as you did your topic (steps 3–7). |

[a] The reader is referred to Chapters 10 and 11 in Engelmann and Carnine (1982) for methods of deciding whether related properties and topics should be taught.

matched to the functional typology of instructional tasks. If one has decided to concentrate on teaching definitions of the topics, then one would probably concentrate on definitional tasks for the subcomponents of these topics as well. As stated earlier, however, if one is teaching complex, conceptual behavior, then the program will probably require a variety of instructional tasks (e.g., defining, identifying, exemplifying, etc.). The interaction of the topical analysis and the functional typology becomes the list of tasks that the student completes.

*Analyzing How to Teach*

The second category of the instructional model, a logical analysis of how to teach, subsumes steps six and eight of the systems model: programming and program revision. These steps can be made explicitly behavioral by adding subroutines for producing and presenting instructional materials to students that are based on principles of behavior. Details on each of these steps can be obtained elsewhere in the behavioral literature (cf. Holland, Solomon, Doran, & Frezza, 1976; Sulzer-Azaroff & Mayer, 1977; Vargas, 1977; White & Haring, 1980). These steps are also consistent with a number of different forms of behavioral instruction (Howard & Johnson, 1983; Johnson & Ruskin, 1977). Table 4 presents these in checklist form for use as prompts when designing instructional materials.

*Evaluating What Has Been Taught*

Finally, the third category of behavioral instructional model subsumes steps 4, 5, 7 and 9 of the systems model: assessing entering skills, evaluating the program, and evaluating the revised program. These are the evaluation steps for which the behavioral model has particularly rigorous views. I assume that the closer evaluation is to an experimental design, the more and better the information that will be gained.

First, one should evaluate a student's entering repertoire by testing those behaviors that have been precisely defined when describing the goals and objectives of the program. One should, however, also test for more general skills. For example, reading fluency in the social sciences is probably a general skill that interacts with learning specific psychological concepts. Thus, testing for reading fluency is recommended.

Second, one should collect data on changes in the students' verbal skills. Data collection should conform as closely as logistically possible to an intrasubject experimental design (Johnston & Pennypacker, 1980; Sidman, 1960). This involves demonstrating that the instructional program is systematically related to the changes that occur in the students' skills by determining incompatible results and minimizing alternative explanations for the students' progress. Perhaps the most convincing demonstration that the teaching procedures are responsible for changes in student behavior is to reverse these changes by withdrawing the program. This, however, is often logistically impossible. Therefore, other experimental procedures can be implemented, such as multiple-baseline achievement tests (Cayton & Madsen, 1975; Miller & Weaver, 1972). This procedure involves multiple tests in which each test assesses all the skills or a sample of the skills that are taught within a program. For instance, each test could assess performance on three sets of objectives: 1) a sample of those that the students have already completed successfully on previous tests, 2) those practiced in the current lesson, and 3) those that will be practiced in the next lesson. Experimental logic would indicate that students should respond correctly to items based on objectives that have been covered in the program and incorrectly to items not yet taught. In addition, the instruction could be staggered across students. Again, if changes in students' skills occur when they have received instruction related to those skills, and not beforehand, then one can assume that the program is responsible.

Third, the behavioral model suggests that data collection be calibrated. This involves periodically checking the tests and test scoring. In order to determine whether different tests are parallel (i.e., test the same skills, but with different items), a small sample of students needs to be exposed to the parallel items. If the students answer one of the parallel items correctly, they should also answer the other items correctly. Likewise, if the students are incorrect on an item, they should not be able to answer the parallel items. Another type of calibration is related to scoring the test items. First, detailed answer keys should be written. These include an outline of the answers expected, acceptable alternative answers, and the number of points assigned to each part of the answers. Second, tutors, proctors, and/or test scorers should be taught how to score the test items. Different training will be required for the different kinds of relations (i.e., scoring definitions is different than scoring exemplifications). All training, however, should include in-

**TABLE 4**

**A checklist of instructional features**

| | | |
|---|---|---|
| ____ | 1. | Teacher informs students of the overall goals of program. |
| ____ | 2. | Teacher selects tasks that will lead to the accomplishment of the overall goals of the program. |
| ____ | 3. | Teacher checks to make sure all tasks are consistent with the objectives. |
| ____ | 4. | Teacher provides instruction at each step in the program. |
| ____ | 5. | Teacher presents a progression of the tasks that increase in difficulty. |
| ____ | 6. | Teacher prompts at the beginning of program and gradually removes prompts as the student progresses through the program. |
| ____ | 7. | Teacher presents tasks that ask the student to discriminate between stimulus classes and generalize within stimulus classes. |
| ____ | 8. | Student makes an observable response or leaves an observable product of responding. |
| ____ | 9. | Teacher presents knowledge of results or corrective consequences to the student. |
| ____ | 10. | Corrective consequences are immediate. |
| ____ | 11. | Corrective consequences are contingent. |
| ____ | 12. | Corrective consequences are differential. |
| ____ | 13. | Teacher provides remediation of incorrect responses. |
| ____ | 14. | Peers provide tutorial assistance (this is optional, but helpful). |
| ____ | 15. | Student/teacher and/or student/peer tutor interactions are frequent. |
| ____ | 16. | Students pace some aspects of program. |
| ____ | 17. | Teacher paces some aspects of program (e.g., at least tests or probes are paced by the teacher). |
| ____ | 18. | Teacher sets mastery criteria for accuracy. |
| ____ | 19. | Teacher sets mastery criteria for fluency. |
| ____ | 20. | Teacher collects data on accuracy and rate of student responding. |
| ____ | 21. | Teacher uses data to decide what changes need to be made in the program. |

**TABLE 5**

**Checklist of evaluation steps**

| | |
|---|---|
| ____ | 1. Define the target relations that you wish to teach. Use the questions from Tables 2 and 3 to help you. |
| ____ | 2. Design a series of tests that include items based on the precisely defined target relations. |
| ____ | 3. Include items on the tests that you assume the students can answer correctly and that are prerequisites for the targeted relations. |
| ____ | 4. Devise parallel forms of your tests. Test items should *not* be identical across tests, but should test the same targeted relations. |
| ____ | 5. Test parallel items with a sample of students. |
| ____ | 6. Check to see whether the sample of students answer the parallel items consistently. |
| ____ | 7. Give the tests to all students as often as is logistically possible. |
| ____ | 8. Design detailed answer keys. Include an outline of expected answers, alternative acceptable answers, and points assigned to each component of the answers. |
| ____ | 9. Train your test scorers. |
| ____ | 10. Probe your test scorers periodically for agreement. |
| ____ | 11. Incorporate features of experimental design into your program (e.g., use a multiple-baseline achievement test or stagger your programs across students). |
| ____ | 12. Assume that any component of your program could be changed to make your program better (e.g., including the tests themselves). |
| ____ | 13. Be sure test items are consistent with your objectives. |

structions, modelling, practice, and corrective consequences. In addition, training should include periodic checks and consequences to keep the scoring calibrated.

Finally, one should always consider the fallibility of their assessment so that they continue to examine the tests for possible flaws. Often, it is tempting to maintain the tests and keep changing the instruction until test performance improves. This logic is fine if the test items really test the objectives, but one can never be so assured. Thus, one should periodically check the test items to make sure they are reliable, worded correctly, and consistent with the objectives.

Table 5 presents a checklist of evaluation features that might be incorporated into any program. These evaluation steps may seem a bit time consuming, but I am reminded of directions supplied by Markle (1967): Programming is an empirical process. If teachers collect as much information as possible within the logical context of an experimental design, they will more likely pin-point the relations between the instructional program and student learning.

In sum, this section suggests that behavior analytic strategies can be applied to the design of complex instructional programs if some basic features of a behavioral model are clarified for those authoring instructional programs. Specifically, analyses of what to teach can be assisted by functionally analyzing both the tasks students will perform and the content incorporated in those tasks. Tables 2 and 3 should be helpful for conducting these analyses. In addition, analyses of how to teach can be assisted by attending to the literature on discrimination and generalization, prompting and fading, control by consequences, and other components from behavioral instruction. Table 4 lists a number of these components. Finally, the effectiveness of the programs can be evaluated by including intrasubject experimental tactics. Table 5 lists some of the tactics that should be part of instructional program evaluation.

## CONCLUSION

This paper has described two ways that the behavior analytic model can have an impact on the design of complex instructional programs. The first method suggests how those who have expertise in applying principles of behavior to instruction can easily become involved in the development of courseware. They simply buy an authoring system according to the suggestions provided in Table 1 and get to work. The second method suggests how those who have expertise in behavior analysis, but not necessarily instructional design, can learn how to design sound instruction. This may be a more difficult task, yet I hope that the prompts listed in Tables 2–5 will facilitate this task. I assume that readers without behavior analytic skills will require a more elaborate and detailed set of instructions. Perhaps the references from the instructional design section could be used to establish a curriculum for teaching these skills. What I have not discussed yet is some of the problems related to this strategy for designing courseware. I would like to conclude this paper by doing so.

The biggest difficulty that I see with developing computer-assisted programs is that most authoring systems limit the authors' choice of task types to either matching or other choice responses (e.g., multiple choice questions or example identification tasks), or to simple, short constructed responses (e.g., copy tasks or fill-ins). This is due to a technological limitation: computers cannot yet respond to as large a range of verbal statements as humans, and therefore can only correct and give corrective consequences to fairly circumscribed student responses. Even this problem can be overcome, however, by designing a data collection system that records the complete answers that students make to complex constructed response questions (e.g., exemplifications and definitions). If this data collection system is incorporated within a program that includes other task types, the student could receive immediate feedback on the other tasks and delayed feedback on the constructed response tasks. For example, a program that teaches reinforcement could start with example identification tasks for which the computer provides immediate corrective consequences. Then, either interspersed with the example identification tasks or at the end of a sequence of such tasks, the program could present exemplification tasks. Although the computer would not give corrective consequences for the students' exemplifications, it could tell the students to signal the teacher. Then the teacher or tutor could tell the students whether they were correct and why. This procedure might be enhanced further by a system that includes a master computer station. The teacher could then interact with the student directly through their respective computers. If the teacher could not respond to the student immediately, the student could be told to go on to the next step in the program or to an enrichment exercise until the teacher has a chance to check the exemplification answer.

In sum, if behavior analysts are creative with their use of the existing technology, they can make it conform to the criteria that have been specified in this paper. Courseware development, like other instructional development, is a complex and time-consuming task. This task can be managed, however, if the computer expertise provided by authoring systems and the instructional design expertise provided by suggestions such as those made here are used.

Before I can predict the efficacy of the suggestions provided, however, I have to practice the philosophic doubt that is part of the behavioral model (Deitz, 1982). I have put together a system that works for me and I believe will work in general. The system is based also on experimentally verified procedures. The overall system, however, has not been thoroughly experimentally analyzed. Experimental analyses still need to be conducted, and when done should suggest changes, additions, and deletions in the overall system. In addition, some critical components of the model have not been specified. For example, there is little empirical evidence on methods of sequencing related topics. I have left this to the discretion of the content expert (see Table 3), yet there must be more or less effective ways of organizing such curricula (cf. Engelmann & Carnine, 1982). A radical behavioral approach borrows from Claude Bernard the ever-questioning, never-satisfied philosophic doubt of natural science (Deitz, 1982). I believe in continuing this tradition in order to make advances in instructional technology.

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