The Behavior Analyst 1995, 18, 293–299 No. 2 (Fall)

Fostering Multiple Repertoires in Undergraduate Behavior Analysis Students

David A. D. Polson
University of Victoria

Eight techniques used by the author in teaching an introductory applied behavior analysis course are described: (a) a detailed study guide, (b) frequent tests, (c) composition of practice test questions, (d) in-class study groups, (e) fluency building with a computerized flash-card program, (f) bonus marks for participation during question-and-answer sessions, (g) student presentations that summarize and analyze recently published research, and (h) in-class behavior analysis of comic strips. Together, these techniques require an extensive amount of work by students. Nevertheless, students overwhelmingly prefer this approach to the traditional lecture-midterm-final format, and most earn an A as their final course grade.

Key words: college instruction, behavior analysis, study guide, frequent tests, practice test questions, study groups, fluency, student presentations

This paper describes eight teaching strategies designed to help college students acquire multiple repertoires with respect to behavior analysis content. Students with such repertoires can focus on important textual material, read critically, correctly answer course-relevant questions at various levels of complexity (Sanders, 1966), talk intelligently about the content, and apply course concepts to novel situations. These procedures were developed over 10 semesters of teaching an introduction to applied behavior analysis course, consisting of four winter sections (typically three 50-min classes per week for 13 weeks) and six condensed summer sections (typically 3.5-hr classes, every other day for 3 to 4 weeks). Class size has ranged from 44 to 75 students during the winter sections and 18 to 30 students during the summer sections. Although the strategies have been developed and are presented as an integrated set, they may be effective in other course arrangements when used individually or in combination with other teaching methods.

I am most grateful to Joe Parsons for all his support over the years. I would also like to thank Bill Heward and Dick Malott for their helpful feedback.

Address correspondence and requests for reprints and copies of course materials to David Polson, Counselling Services, University of Victoria, P.O. Box 3025, Victoria, British Columbia V8W 3P2, Canada (E-mail: polson@islandnet.com).

Study Guide

Consistent with Michael's (1991) recommendations, I have written a study guide to accompany the course textbook (Lutzker & Martin, 1981). The required reading for each test is one or two chapters from the textbook. The study guide lists 17 to 32 short-essay study questions for each of these required readings. Students are told that all test items about the required readings are derived from these questions and that they should prepare for tests by writing out the answers. Most study questions ask for factual information, such as defining terms and summarizing key features of studies reviewed in the textbook; in some cases, however, the questions require more critical thinking, such as supplying examples of concepts. Although grades are not directly contingent on using the study guide, there are other less explicit consequences for closely following it when reading the textbook. First, study efficiency is improved by concentrating only on textual material on which test items will be based. Second, if students compose practice test questions (see PTQ section below) based on unimportant information from the text-

book, they earn lower grades on that exercise.

Frequent Tests

Students write 10 tests at regular intervals throughout the course. Each test takes no longer than 15 min to complete and consists of 15 multiple-choice and true-false questions. Most test items are based on the required reading, but a few questions ask for information related to class events since the last test (e.g., a guest lecturer) and novel examples of concepts covered earlier in the course. We orally review the correct answers in class immediately after test completion. The lowest test score is dropped for each student, with the remaining scores comprising 55% of the final course grade.

Practice Test Questions

Books on improving study skills in college often recommend that students write questions based on their readings (Pauk, 1989), and research has demonstrated the effectiveness of doing so (Owens, 1980). Students submit a practice test question (PTQ) assignment each test day. They are required to compose one true-false and two multiple-choice questions. Two of the questions must be based on the required reading, and the third, weighted most heavily, must be a multiple-choice question involving a novel example of one of the main course concepts. The assignments are graded, usually with written feedback, and returned by the next class. To obtain all 10 possible points for each PTQ assignment, a student must (a) include the answer to each question along with the page in the text that corresponds to that answer, (b) provide a rationale for the answer to the novel example question, (c) include at least four alternatives for each multiple choice question, (d) ensure that his or her questions are different from fellow study group members' questions (see Study Group section below), and (e) not submit PTQs that ask for information such as specific names, dates, and statistics. These criteria, which are clearly stated in the course outline along with several sample PTQs, gradually evolved over the years to avoid pitfalls that had been observed in previous sections. For example, without instructions to do otherwise, students often asked for trivial facts in their questions, such as the name of an author of a particular study, even though they are not required to learn this information for tests.

The 10 PTQ assignments are worth 10% of the final course grade. Grades, however, may not be the only important consequence for this exercise. Informal observations indicate that with repeated practice students get better at producing questions that approximate actual test questions. In addition, students receive feedback on their PTQs from their study groups.

Study Groups

On the first day of class, students team up with 3 to 5 other students to become members of a study group for the remainder of the course. Study groups meet during class for 25 to 30 min prior to each test. Members pass around and answer each others' PTQs by marking an answer sheet provided at the beginning of class. Then, in turn, they read aloud their PTQs with the answers while other group members self-record the accuracy of the answers they selected and rate each PTQ as either *poor, OK,* or *good* on their answer sheets. Study groups spend the remaining time discussing problems with the required reading and then submit both their PTQs and answer sheets before the test begins.

In earlier sections of the course, answer sheets were not part of the procedure, which made it possible for some students to opt out of active participation in their study groups with no consequence. To circumvent this problem, students are no longer assigned a grade for their PTQ assignment unless it is accompanied by a completed an-

swer sheet. This permanent product of their participation greatly improved student interaction within the groups.

The study group procedure gives students test-taking practice and feedback immediately prior to taking the actual test. It involves them in verbal responses under conditions in which they and their listeners are primed to participate and understand. Finally, it provides an opportunity for them to practice "thinking on the spot" as both a student and teacher.

Fluency Building

Teachers want their students to become fluent with the subject matter. This is especially important in behavior analysis, where colloquial and technical definitions often collide and impede students' progress with learning the vocabulary (Catania, 1992). Fluency with technical meanings may be a basic skill that is necessary to perform more complex behavior such as analysis and application (Binder, 1993; Johnson & Layng, 1992). Precision teaching research indicates additional benefits of fluency building for college students, such as improved retention and essay writing (McDade, Rubenstein, & Olander, 1983; Olander, Collins, McArthur, Watts, & McDade, 1986).

For these reasons, students use the Think Fast computerized flash-card program (Parsons, 1989) to develop fluency with 52 items that serve as the foundation of the course.[1] An item consists of a behavioral term (e.g., *stimulus control*) and its definition. Students purchase a computer disk containing a copy of the program from the university bookstore. During the first half of the semester, one class day per week is scheduled for Think Fast practice in the computer lab. Attendance at these scheduled practices is optional, and many students prefer to work on their computers at home. This is possible because Think Fast records to disk all relevant keystrokes and their time of occurrence and converts these data to performance measures. The results are later captured from each student's disk using the teacher's utility program.

Points toward the course grade have been assigned for various Think Fast performances and levels of mastery over the years. In the most recent summer section, I customized Think Fast (using the teacher's utility program) so that it presented the items one at a time, with each item randomly missing either the term or a key word (or phrase) from the definition. The student's task was to type the missing word or words. On each trial, the program shuffled the entire deck of 52 items and the student had 2 min to answer as many items as possible. Students were required to (a) practice at least 80 trials and (b) obtain mastery on at least 35 trials; each requirement was worth 5% of the final course grade. A mastery trial consisted of a rate of at least five correct responses per minute with an error rate of less than one response per minute. Although there was considerable variability in the amount of time students needed to meet these criteria, all but 1 of 21 students achieved full marks. Students in other sections have had similar success with different fluency criteria (e.g., saying the answers at a much higher correct rate).

Although grades are contingent on Think Fast performance to ensure that students use it to develop fluency, the program contains other potentially important built-in consequences that may help sustain practice, such as immediate feedback after each trial and graphs that chart performance across trials. On the course evaluation, 77% of 242 students from eight sections reported that they would use Think Fast if it were available on an optional basis to help them learn the terminology in their other courses.

[1] Requests for a demonstration copy of Think Fast should be sent to Joe Parsons, Counselling Services, University of Victoria, P.O. Box 3025, Victoria, British Columbia, V8W 3P2 Canada (E-mail: jparsons@sol.uvic.ca).

Question-and-Answer Sessions

Unannounced lectures occur infrequently throughout the course. Some of this time is used for traditional teacher talk (i.e., presenting information), but the main focus of these periods is on the behavior of students. I call a student's name from the class list and ask the student to answer one or two study questions from that day's required reading. Any valid attempt earns a bonus mark of 1% added to the student's final grade. There is no penalty for not answering. Students are allowed to read their answers from their notes to get started, but if they do, I then usually ask them to expand or say it in their own words.

These question-and-answer sessions provide students with the opportunity to talk about the material in the presence of receptive listeners. This procedure offers at least two advantages for the instructor. First, material that is apparently less well understood—as indicated by a student's response to a question—can be discussed more thoroughly in class. Second, given a poor answer, the instructor can shape the correct response on the spot, which may serve as a model for other students. In larger classes, each student is given only one or two opportunities to earn these bonus marks during the semester. However, for students who never say anything (usually the vast majority), this minimal frequency represents a significant gain above baseline levels of participation. On a class-wide basis, teacher–student interactions are greatly enhanced relative to the traditional lecture. Student participation is excellent, and they report that the possibility of being called upon in class to answer a question resulted in coming to class better prepared (see also Acker, 1991).

Presentations

Toward the end of the semester, each study group makes a presentation on an article selected from a list of recent research published in the *Journal of Applied Behavior Analysis*. Study groups prepare their presentations outside of class. Presentations last 20 to 25 min and are followed by a short discussion period. Instructions on how to organize the presentation and the grading scheme are provided in the course outline. In their presentation, each study group must (a) summarize the article's introduction, procedure, results, and discussion sections; (b) address the pros and cons of the intervention and outcomes from a consumer's point of view; (c) relate the study to concepts covered in the course; and (d) perform a contingency analysis of the main treatment effect. Students are encouraged to use role playing to illustrate the procedure and enliven the presentation. As preparation, another journal article is assigned as required reading, and I model an appropriate presentation of that study. Presentations account for 10% of the final course grade, and all study group members receive the same score for their presentation.

This exercise gives students direct access to research they typically learn about only through secondhand sources. It requires additional study group meetings outside of class, but unlike in-class meetings, the environment is less structured and the material is more complex. The presentation is another chance for students to talk in class and is consistent with the notion that one of the best ways to learn something is to teach it (Bargh & Schul, 1980). Because the nature of the task (translation, interpretation, application, and analysis) is difficult, study groups often visit me during office hours for additional discussion and clarification, providing yet another opportunity for them to talk about the course material and receive feedback.

Comic Strip Behavior Analysis

In-class practice of behavior analysis is scheduled at various points during the semester. During these exercises I show students comic strips via overhead transparencies, from which they

select a behavior and perform behavior analyses as outlined in a handout that lists specific rules for identifying examples of positive reinforcement, negative reinforcement, positive punishment, negative punishment, and discriminative stimuli. Students have the option of working in teams or by themselves. Later in the period, I ask them to share their analyses with the class, and individuals who do so earn a bonus mark.

These discussions are enlightening for many students because it soon becomes clear that there is not just one right answer for each comic strip. There are usually multiple kinds of behavior, and therefore multiple contingencies, to consider. Students discover that the same stimulus can serve more than one function, and what appears to be a behavior might be a stimulus, depending upon whose and which behavior is under analysis. Students learn that the same behavior produces multiple consequences, resulting in separate analyses for each one. Building upon each student's analysis of the same comic strip is an excellent means of illustrating the complexity of seemingly simple vignettes.

On the last day of class, students write a closed-book behavior analysis test that consists of 10 short-essay questions. They are asked to identify one reinforcement contingency and one punishment contingency from their choice of three or four never-before-seen comic strips attached to the test. Students must provide a rationale for each answer based on the rules they learned during the in-class exercises. The remaining questions follow up on their answers to the first two questions (e.g., students are asked to identify the discriminative stimulus for the reinforcement contingency in their example and explain their reasoning, and then what would happen if stimulus generalization were to occur, and so on). A week or two before the test, students are given a copy of the 10 short-essay questions along with the answers to a sample comic strip that would earn full marks. The test is worth 15% of the final course grade.

The comic strip behavior analysis gives students additional practice in identifying behavioral principles. Students have an opportunity to share their answers in front of the class and receive immediate feedback and perhaps a bonus mark. The behavior analysis test provides yet another means of practice and assessment (i.e., answering short-essay questions). Like the presentation requirement, the complex nature of this task causes many students to see me during office hours for additional assistance. I tell students to bring in their written answers to practice vignettes so I can show them how I would grade their work.

Summary and Outcomes

Table 1 summarizes each of the eight teaching procedures in terms of the required student behavior, frequency, and consequences. The weekly requirements noted in Table 1 are for winter sections of the course; these are daily requirements for summer sections. Overall, the course demands a considerable amount of active student responding to foster multiple repertoires pertinent to behavior analysis (Heward, 1994; Malott, 1993; Tudor & Bostow, 1991). A student who completes this course (a) reads the textbook to discover the answers to 228 short-essay study questions, (b) writes the answers to those 228 questions, (c) answers 150 multiple-choice and true-false test questions, (d) composes 30 multiple-choice and true-false PTQs, (e) participates in study groups for over 5 hr in class, (f) answers and assesses approximately 150 multiple-choice and true-false PTQs of fellow study group members, (g) obtains fluency with 52 behavioral terms (h) answers one or two teacher-posed questions in class, (i) reads two journal articles, (j) meets outside of class in study groups to plan a 25-min presentation, (k) delivers the presentation in class, (l) performs in-class behavioral analyses of comic

TABLE 1

Summary of the eight teaching strategies

Strategy	Behavior	Frequency	Consequences
Study guide	Student reads textbook to discover the answers to 17 to 32 short-essay study questions	10 weekly assignments	Improved reading efficiency; provides relevant material for PTQ assignments
Frequent tests	Student answers 15 multiple-choice and true-false questions about required reading, class events, and novel examples of course concepts	10 weekly tests	Tests equal 55% of final grade; answers reviewed immediately following test
Practice test questions (PTQs)	Student composes 3 PTQs based on required reading and novel examples of course concepts	10 weekly assignments	PTQ assignments equal 10% of final grade; instructor provides written feedback; study-group members rate each other's questions
Study group	Student answers and rates 15 PTQs of fellow study-group members	10 weekly 30-min meetings	PTQ assignment is graded only if answer sheet is completed
Fluency building	Student practices responding to 52 flash cards of behavioral terms (*Think Fast*)	At least 160 min of timed practice	Marks assigned for (a) practicing and (b) obtaining fluency (each 5% of final grade); program provides immediate feedback and graph of performance over trials
Question-and-answer sessions	Student volunteers answers to study questions in class	One or two opportunities	Student earns bonus mark of 1% added to final grade
Presentation	Study group prepares and presents a summary and analysis of a *JABA* article	One 25-min presentation	Presentation equals 10% of final grade; feedback from other study-group members during preparation
Comic strip behavior analysis	Student performs analyses of novel vignettes, shares answers with class, and writes behavior analysis test	Multiple analyses conducted in class; one or two chances to share answers; 10 short-essay behavior analysis test questions	Feedback from other students (if working in teams) and from instructor; bonus mark for sharing answers of 1% added to final grade; behavior analysis test equals 15% of final grade

strip vignettes, (m) shares those analyses with other students, and (n) writes a behavior analysis test consisting of 10 short-essay questions.

Students' comments on course evaluations have been positive for all eight teaching strategies. When asked if they prefer this approach to the typical lecture-midterm-final format, 86% indicated yes, 8% were neutral, and 6% said no (N = 309 across nine sections). The mean grade for each section is usually within the 80% to 85% range. In sum, students do a great amount of

work, report preferring this format and enjoying the experience, and achieve good grades. For these reasons, I will continue to employ and refine these teaching methods in my efforts to help students learn about behavior analysis.

REFERENCES

Acker, L. E. (1991). The applied behavior analyst. In R. Gifford (Ed.), *Applied psychology: Variety and opportunity* (pp. 217–242). Boston: Allyn and Bacon.

Bargh, J. A., & Schul, Y. (1980). On the cognitive benefits of teaching. *Journal of Educational Psychology, 72,* 593–604.

Binder, C. (1993). Behavioral fluency: A new paradigm. *Educational Technology, 33,* 8–14.

Catania, A. C. (1992). *Learning* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Heward, W. L. (1994). Three "low-tech" strategies for increasing the frequency of active student response during group instruction. In R. Gardner, III, D. M. Sainato, J. O. Cooper, T. E. Heron, W. L. Heward, J. Eshleman, & T. A. Grossi (Eds.), *Behavior analysis in education: Focus on measurably superior instruction* (pp. 283–320). Monterey, CA: Brooks/Cole.

Johnson, K. R., & Layng, T. V. J. (1992). Breaking the structuralist barrier: Literacy and numeracy with fluency. *American Psychologist, 47,* 1475–1490.

Lutzker, J. R., & Martin, J. A. (1981). *Behavior change.* Monterey, CA: Brooks/Cole.

Malott, R. W. (1993). Why we fail to train expert behavior analysts. *The ABA Newsletter, 17*(1), 48.

McDade, C. E., Rubenstein, S. B., & Olander, C. P. (1983). Parallel between frequency testing and performance on essay questions in a theories of personality course. *Journal of Precision Teaching, 4,* 1–5.

Michael, J. (1991). *How to teach a college content course.* Unpublished manuscript. Western Michigan University, Kalamazoo, MI.

Olander, C. P., Collins, D. L., McArthur, B. L., Watts, W. O., & McDade, C. E. (1986). Retention among college students: A comparison of traditional versus precision teaching. *Journal of Precision Teaching, 4,* 80–82.

Owens, A. M. (1980). Generative and passive questions in learning from text. *Perceptual and Motor Skills, 51,* 714.

Parsons, J. A. (1989). Think fast [Computer program]. Victoria, BC: Author.

Pauk, W. (1989). How to study in college (4th ed.). Boston, MA: Houghton Mifflin.

Sanders, N. M. (1966). *Classroom questions: What kinds?* New York: Harper & Row.

Tudor, R. M., & Bostow, D. E. (1991). Computer-programmed instruction: The relation of required interaction to practical application. *Journal of Applied Behavior Analysis, 24,* 361–368.