INTRODUCTION

How one teaches course content and manages classroom behavior are often compartmentalized as separate educational issues when, in fact, research suggests that the two are interrelated (Clarke et al., 1995; Dunlap et al., 1993; Gunter & Reed, 1997; Gunter, Shores, Jack, Denny, De Paepe 1994; Kauffman, 2001). More directly, when teachers present information to students following the explicit instruction format associated with scripted Direct Instruction lessons (Gunter, Hummel, & Conroy, 1998; Gunter & Reed, 1997), with scripted Direct Instruction lessons (Martella & Johnson, 2003), students' achievement increases and often their misbehavior, collaterally, decreases. In this chapter, we define explicit instruction, provide a rationale for explicit instruction, describe how teachers can employ the components of explicit instruction, and explain how its systematic use can result in both improved academic achievement and decreased undesirable behavior of students. When teachers employ well-developed scripts, students are more actively engaged with the content and, as a result, more of them master the content.

DEFINITION OF EXPLICIT INSTRUCTION

There are several different labels for what we refer to as explicit instruction. These labels include effective instruction, systematic teaching, and active
teaching (Rosenshine & Stevens, 1986). Whichever label one employs, the technique involves a teacher-centered classroom where the teacher delivers content to students in a bottom-up (piece-by-piece) process, with the students actively engaged with the material presented. Conceptually, we can view this model of instruction as a specific form of what Slavin (2000) calls the seven-step Direct Instruction (DI) lesson. Critical features of Direct Instruction lessons include highly sequenced instruction, clear and concise directions, teacher guidance, active student participation, and assessment probes in order to practice and master new knowledge and skills. The seven sequential parts to a DI lesson are (1) gain learner's attention, (2) review prerequisites, (3) present new content, (4) probe learning, (5) provide independent practice, (6) assess performance and provide feedback, and (7) provide distributed practice and review. Explanations for each step in a DI lesson are presented within the framework of developing scripted lessons.

SCRIPTED LESSONS

Planning and implementing direct instructional lessons is important for student achievement and teacher accountability. Over the course of the year, teachers often engage in a variety of routinized schedules and activities. Frequently, these routines drive the structure of the day, regardless of whether students are actively learning new knowledge and skills. All forms of explicit instruction simply reflect highly structured teacher routine.

Commercially available Direct Instruction programs reflect explicit instruction (e.g., Science Research Associates' Reading Mastery and Saxon's Algebra 1/2). We can choose, however, to develop original direct instructional lessons by scripting. Developing one's own scripted lessons is a straightforward task that practicing educators can do by themselves and has the added benefit that this powerful instructional tool can be applied to virtually any course content for all levels of students.

Typically, scripted lessons are planned for teaching academic skills that comprise a series of chained behaviors such as spelling and math computation, as well as discrete behaviors such as vocabulary terms and math facts. In essence, a teacher would plan a scripted lesson for acquisition of knowledge and skills where there are distinct steps to completing the academic task. Scripted lessons, though, should not be limited to just those academic tasks that teach concrete skills. Bloom et al. (1956) identified six levels of learning within a hierarchy beginning with knowledge (basic recall) and progressing through comprehension (summarizing and paraphrasing accurately), application (generalizing skills and knowledge to new settings and situations), analysis (breaking content into its pieces), synthesis (using learned skills and knowledge to create, for the student, something new), and evaluation (judging merits by
7. Teacher-Made Scripted Lessons

comparing to standards). Teachers can also prepare scripted lessons that reflect these advanced levels of learning. In the following sections, the procedures for scripting will be integrated into the parts of a seven-step direct instruction lesson.

**ORIENT AND REVIEW**

New lessons begin by gaining student attention and revisiting pertinent skills and knowledge previously taught. Often, teachers accomplish this by only reviewing content covered earlier. Generally, though, an effective scripted lesson will begin with a brief overview highlighting what the day's lesson will cover to activate students' prior knowledge they possess about the content and should end with a description of the day's learning outcomes or objectives. The review (step 2 of the seven-step DI lesson) will then allow teachers to carry out several teaching functions such as focusing student attention on the task, probing student understanding of content, providing review opportunities for students, and providing opportunities for corrective feedback or positive feedback to students. In Direct Instruction, both review and new information are presented in small pieces. After each piece, students typically must make a choral response signaled by the teacher. Because information is presented in small pieces the pace is quick, and students are actively responding throughout. The fast pace of evoking student responses (9 to 12 per minute), associated with the high level of accuracy desired of those student responses (at least 90%) during review of previously learned material, also sets the stage for the response momentum phenomenon to occur when more difficult tasks (e.g., questions at the higher levels of the Bloom taxonomy) are interspersed among less difficult ones (Davis, Brady, Hamilton, McEvoy, Williams, 1994). When students are on a roll (i.e., correctly answering questions related to pieces of information presented by the teacher), they are also more likely to perceive (and correctly respond to) questions requiring critical thinking (i.e., the higher levels of the Bloom taxonomy).

All lessons are based on clearly stated and communicated objectives that specify what the students should be able to do or say after the lesson. Formats for reviewing previous content can take many shapes. For example, teachers may plan a series of higher order questions in a sequence based the Bloom taxonomy in order to review and assess previous learning. Teachers can divide the class into two teams, and the students can then devise questions for the other team to answer based on previously learned material. A commonly used review strategy is having students check homework assignments. Remember that the goal is to review previous content, check for student acquisition, and determine whether re-teaching is required for content necessary to work with the new information or procedures to be presented.
A primary defining characteristic of effective instruction is that new content is presented in small steps (a bottom-up approach; see Slavin, 2000). In the following text, procedures for presenting new information are analyzed. It goes without saying that the educator's objectives should clearly state what the students are to say or do rather than employing ambiguous terms such as know or understand. Additionally, it is axiomatic that teachers must be able to do the complex outcomes specified in course objectives. Suppose one of a teacher's goals is for students to learn how to add two two-digit numbers. The objective for this could be "After the lesson on addition, students will correctly hand-compute 50 addition problems involving two two-digit numbers and regrouping with 90% accuracy in 10 minutes or less."

When the objectives have been well defined, the next step in developing an explicit lesson plan involves identifying the step-by-step progression for successfully completing the academic task. This is formally called a task analysis (Gagne, 1962). Conceptually, a complex activity specified in an objective is delineated into subcomponent behaviors that are placed within a sequential order. The key is to make certain that each subcomponent identifies an overt action that the students must perform. To begin a task analysis, simply list, in order, the first thing to do, the second, the third, etc., until the complex action stated in the objective is completed. It is a straightforward process but novices often make predictable mistakes. The most common mistakes include: (1) skipping steps, (2) not specifying an overt action at each step, and (3) not having enough steps.

Generally, teachers are masters of their content, and they perform the tasks associated with their objectives almost by rote because they have practiced them countless times. Because it is so easy for teachers to do complex activities, it is a good idea to double check the sequence of their academic content to ensure that critical steps have not been skipped. Once the steps are rechecked, colleagues can be asked to review them, also. Specifying an overt action at each step is vital because it provides the teacher and learner with an objective reference point, or behavioral anchor, to monitor progress. No one can objectively know if a person has actually acquired a skill until the person demonstrates it; when students can do the skill, it can be mastered at the level specified in the objective through practice and with feedback.

The number of subcomponents skills in a task analysis may range from 3 steps to as many as 15 or more. As Gagne (1977) pointed out, we should continue breaking down the objective's activity until the first step is a behavior that everyone in the class can do without training. Table 1 highlights examples of how to delineate the steps of adding two-digit numbers with and without regrouping, while Table 2 specifies the steps to follow to correctly use the apostrophe. Each complete task analysis is the basic starting point for the
TABLE 1
Identifying the Subcomponents of Teaching Two-Digit Addition With and Without Regrouping

<table>
<thead>
<tr>
<th>Step</th>
<th>Subcomponent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Copy the problem (if not already on a provided sheet), making certain that one of the numbers is above the other, the 1's and 10's place values for both numbers are aligned, and the bottom number is underlined.</td>
</tr>
<tr>
<td>2</td>
<td>Add the 1's place values together, and if the sum is less than 10 write their sum below the horizontal line aligned with the 1's place of the original numbers.</td>
</tr>
<tr>
<td>2a</td>
<td>If the sum is greater than 10, write the 1's value of the sum below the line and carry the 10's value by writing that value above the top digit in the problem's 10's place.</td>
</tr>
<tr>
<td>3</td>
<td>Add the 10's place values, including any carryover from the 1's sum to the left of the 1's sum and below the 10's values of the original numbers.</td>
</tr>
</tbody>
</table>

TABLE 2
Identifying the Subcomponents of Teaching How To Use the Apostrophe

<table>
<thead>
<tr>
<th>Step</th>
<th>Subcomponent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>After writing a sentence, reread the sentence aloud. If the sentence contains any contractions (e.g., isn't, I'm), the omitted letter is replaced with an apostrophe.</td>
</tr>
<tr>
<td>2</td>
<td>In the sentence you just read, also look for nouns that denote ownership/possession. If the noun is singular, add an apostrophe s ('s) after the last letter of the noun. If the noun is plural, add an s followed by an apostrophe (s').</td>
</tr>
</tbody>
</table>

scripted lesson the educator develops to teach students the series of discrete behaviors identified in the complex action specified by an objective.

PRACTICE

For each subcomponent of the task analysis, the teacher provides clear instruction and explanation and models the step to provide guided practice to students. During the numerous group and individual practice opportunities, the teacher initially uses prompts to guide the student through the steps delineated in the task analysis (and later through activities composed of multiple steps) and fades this assistance as the students acquire mastery of the content. For example, suppose a teacher had recently taught students how to show possession by using apostrophes. While these students complete a worksheet that requires them to correct sentences illustrating possession, the teacher might verbally prompt them to use “apostrophe s” for singular cases, and "s apostrophe" for plural ones. In later exercises, instead of providing the prompt to the entire group, the teacher will monitor the work of individuals and might give the prompt to an individual incorrectly using the “apostrophe s”
when the plural form is needed. Additionally, in this instance, the teacher may first, before giving the original prompt, ask the student: "Is the possessive word singular or plural? What is the possessive rule for each?" Over trials, the amount of cueing information given to the student is decreased. The steps for guided practice are model, probe, and then check.

**Model**

The teacher models or demonstrates the correct sequence of behaviors required for successful completion of an academic task. Teachers should select a model based on the needs of the student and the academic task. Typical models could be verbal (e.g., verbally stating each letter of a word in sequential order), written (e.g., steps to complete the problem are written at the top of the page), pictorial (e.g., picture cue demonstrating an action), or a *physical demonstration* (e.g., the teacher demonstrates the physical actions required to complete the appropriate step). Instructional modeling should ensure student responding and be specific to the academic needs of the students. In a scripted verbal presentation, the teacher presents a piece of information and then asks a question derived from the piece of information. This is very different from the way in which most teachers present information in at least two ways. First, the information is delivered to the students in small pieces rather than complete wholes. Second, the information is presented to the students in an answer-and-question format instead of the more traditional question-and-answer form most teachers employ. For example, if you were introducing students to the six levels of the Bloom taxonomy of cognitive objectives, your script might look something like this:

The Bloom taxonomy has six levels.

*How many levels does the Bloom taxonomy have?*

The first level is the knowledge level.

*Name the first level.*

The second level is comprehension.

*Everyone, what's the name of the second level?*

*Now name the first two levels.*

The third level is called application.

*What is the name of the third level?*

*Everyone, name the first three levels of the taxonomy.*

The piece of information the teacher presents in the script is based on the steps in the objective's task analysis. Typically, the teacher's question is one that the entire group answers rather than being directed to an individual. For example, when teaching students how and when to use the apostrophe, the teacher might first say: "The apostrophe is used to indicate either a contraction or possession." After making the statement, the teacher could ask the following question that the students would answer in unison: "Apostrophes are used to indicate contractions and _____." As soon as the question is
delivered to the students, the teacher gives a signal (thumb snap, hand drop, etc.) to cue the group to answer the question as a group.

**Probes and Checks**

The teacher should informally assess (i.e., these assessments do not affect students’ grades) student acquisition of new knowledge and skills. Oral probes requiring choral or individual responses (checks) are done while teaching new content (i.e., during step three of the direct instruction lesson). Written exercises, another type of probe, are usually done after presenting the lesson and help students learn the material and achieve a higher level of fluency (accuracy plus speed). All probes and checks provide the teacher with data that can support whether progress is being made toward achievement of the objectives. If students are not answering probes fluently, the teacher has real-time achievement data suggesting where re-teaching or additional practice is needed, which is one of the characteristics of effective instruction (see Chapter 2 for a discussion of the characteristics of effective instruction). Because instruction is usually presented to the entire group, most oral probes are designed to prompt a choral group response. Written exercises can be done individually or as a group activity. All probes and checks provide the teacher with data that can support whether progress is being made toward achievement of the objectives and where re-teaching may be needed.

Because content and skills are taught in small steps, student responses are almost always correct and can trigger positive feedback from the teacher. Incorrect responses trigger non-punitive corrective feedback and are easier to rectify because the failure invariably is associated with the most recently modeled step. After the choral response, the teacher can either model the next step or ask an individual student a follow-up question related to the step to ensure that all students are engaged with the material. After presenting the first two steps of an objective, the learning process can be facilitated by modeling these steps in sequence. As additional steps are modeled, teachers should precede each new step by demonstrating, probing, and checking the previous steps completed in series. Table 3 presents an example of a scripted lesson for teaching students to add two two-digit numbers together, and Table 4 provides an example of a scripted lesson designed to teach students how to correctly employ the apostrophe when writing. When learning is occurring at the preset mastery level, teachers should transition to providing practice at the independent level.

**FORMAL ASSESSMENTS**

Steps 5 (independent practice), 6 (exams), and 7 (distributed practice) are all formal assessments. Because performance on these activities affects students'
TABLE 3
A Scripted Lesson for Teaching Two-Digit Addition With and Without Regrouping

<table>
<thead>
<tr>
<th>Step</th>
<th>Script</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to now we have been adding one number to another. Today we are going to learn how to add two-digit numbers together. Two-digit numbers have two values; a 1’s value and a 10’s value. In the number 34, the 1’s value is 4 and the 10’s value is 3. What is the 1’s value in the number 47? (signaled—either by hand or sound—choral response followed by praise) What is the 10’s value? (choral response) Good! The first thing we have to do when adding two two-digit number together is to make sure that the two numbers are arranged so that the 1’s value of the first number is right above the 1’s value of the second number, and the 10’s value of the first is also right above the 10’s value of the second. When we copy a problem, where should the 1’s values of the two numbers be? (choral response) Yes, the 1’s place for both numbers should be one above the other. Where should the 10’s place values be? (choral response) Good! After we write the two numbers to be added we draw a horizontal line under the bottom number. Where does the horizontal line for each addition problem go? (choral response) That’s right, under the bottom number. Copy this problem so the numbers are positioned for us to add them together: 16 + 22. (Check each student’s work.)</td>
</tr>
<tr>
<td>2</td>
<td>When we have copied the problem, we first add the two 1’s value numbers. What do we add together first, the 1’s value numbers or the 10’s value numbers? (choral response) Right! We add the 1’s values first. If the sum of the 1’s values is 9 or less, we write the sum under the 1’s place below the horizontal line. The sum of 6 plus 2 is? (choral response) Correct, it is 8. Write the number 8 below the horizontal line under the 6 and 2. (Model the step and check each student’s work.)</td>
</tr>
<tr>
<td>2a</td>
<td>If the sum of the 1’s value numbers is more than 9, we have to write the 1’s value sum below the horizontal line and write the 10’s value above the 10’s value numbers that are above the horizontal line. If the sum of the 1’s values is more than 9, what do we do? (choral response) Yes, we write the 1’s value of the sum below the horizontal line, and carry the 10’s value to the 10’s column.</td>
</tr>
<tr>
<td>3</td>
<td>When we have added both the 1’s values together and written their sum below the horizontal line, we add the two 10’s value numbers together and write their sum below the horizontal line. What is the sum of 1 and 2? (choral response) Right! It is 3. Watch where I write the sum of the 10’s values. (Teacher models) Now you write the sum on your paper. (Check each student’s work, then perform several other examples for them.) Now I am going to write another problem on the board. Copy it, and add the values together. (Give several problems without regrouping; after checking them, give several that require regrouping.)</td>
</tr>
</tbody>
</table>

grades, teachers should not schedule these events until the probes and checks (especially individually completed written exercises) indicate that students have learned the content.
**TABLE 4**
A Scripted Lesson for Teaching How To Use the Apostrophe

<table>
<thead>
<tr>
<th>Step</th>
<th>Script</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The apostrophe is a type of punctuation. The apostrophe, like commas and periods, is a type of what? (After each question, give a hand or audible signal for the students to respond chorally.) Yes, an apostrophe is a type of punctuation.</td>
</tr>
<tr>
<td>2</td>
<td>The apostrophe looks like a comma but instead of being at the bottom of a word where commas go, it is at the top of the word. What type of punctuation does an apostrophe look like? <em>(choral response)</em> Yes, a comma. (On the board, illustrate and label a comma and an apostrophe.)</td>
</tr>
<tr>
<td>3</td>
<td>Like all punctuation, it is understood when we speak, but we have to write it out when we are writing. In which type of communication do we actually use the apostrophe? <em>(choral response)</em> Yes, when we write; it is understood when we are talking.</td>
</tr>
<tr>
<td>4</td>
<td>The apostrophe is used in two situations when we write. How many ways are apostrophes used? <em>(choral response)</em> That's right, two ways.</td>
</tr>
<tr>
<td>5</td>
<td>The first way we use apostrophes in our writing is when we put two words together to form a single word called a contraction. When you make a single word from two words what is it called? <em>(choral response)</em> Yes, it is called a contraction.</td>
</tr>
<tr>
<td>6</td>
<td>When we combine two words into a single word, we typically drop a letter (sometimes two or three letters) from the second word and substitute the apostrophe sign. What does an apostrophe replace in a contraction? <em>(choral response)</em> Good! The contraction of the two words is written as a single word that contains an apostrophe.</td>
</tr>
</tbody>
</table>
| 7    | Here are some common examples of words that we can make into contractions by: (1) dropping a letter or letters, or (2) writing the words as a single word with an apostrophe in place of the dropped letters (write list on board):  
  
  * I am = I'm  
  * do not = don't  
  * she is = she's  
  * they will = they'll  
  * let us = let's  
  * I would = I'd  
  * we have = we've  
  * should not = shouldn't  

| 8    | Using these examples, change each of the following sets of words into contractions (write list on board):  
  
  * I will  
  * can not  
  * we have  
  * it is  
  * you are  

Now, let's check your work. Watch as I write the correct contraction next to each set of words. Good job, everyone! |
(Call on a student.) I want you to tell me where the apostrophes go in this sentence: “The leaves wouldn’t burn because they weren’t dry.” *(student’s response)* Yes, the sentence needs an apostrophe in the words wouldn’t and weren’t. Good job!

Remember that apostrophes are used in two situations. We’ve just illustrated the first situation. When we make a contraction we use the apostrophe to replace what? *(choral response)* Yes, the missing or dropped letters from the second word. We also use apostrophes to show ownership or possession. Words that demonstrate ownership are in the possessive case. Words that show ownership are in what case? *(choral response)* Yes, possessive case.

Let’s start with nouns. Nouns are names for people, places, ideas/concepts, and things. Nouns are names for what? *(choral response)* Good!

When you have a singular noun, such as girl, man, Ms. Smith, or car, to show ownership you add an apostrophe s (’s) after the last letter of the word. In this list, the noun owns the word that follows it (write sentence on board):

- a girl’s hairstyle
- the man’s wallet
- Ms. Smith’s dress
- the car’s window

If the noun is singular, such as one person, place, or thing, use the apostrophe s form. For example, suppose I want to say something about the performance of Bill on a test. To show that this performance is owned by Bill (and not Margaret), after his name I use an apostrophe s:

*What was Bill’s test score?*

Now, I want each of you to rewrite the following sentences using the apostrophe s correctly (write sentences on board):

*Standardized tests measure a person’s aptitude or ability.*

*The cost of freedom is respect for everyone’s rights, even those we dislike.*

If the noun is plural you generally use the s apostrophe form. For example, suppose I want to know where I have put your test papers (write on board):

*Has anyone seen my students’ tests?*

Now, I want each of you to rewrite the following sentence using the s apostrophe correctly (write sentence on board):

*The students’ performance on the homework assignment was better today.*

*(Check each student’s answer.*)

If the conversion of the noun to the plural form is not an instance where you simply add an s, convert the noun to its plural form followed by the apostrophe. For example, country is singular so its possessive form is country’s, as in:

*my country’s educational system.*

If we were referring to an educational system possessed by several countries (the plural form of country), we would use the possessive plural in this way (write sentence on board):

*These countries’ educational systems are computer intensive.*

Rewrite the following sentence to show plural possession for the following concept (write sentence on board):

*The babies crying was heart wrenching.*
Independent Practice

After modeling, probing, and checking during steps 3 and 4 of the direct instruction lesson, the teacher should provide independent practice (also called *seatwork*) on the material (Heward *et al.*, 1990). Independent practice opportunities should be done individually because the work is assigned a grade. The teacher should monitor the students’ work as it is being done in order to provide prompts/scaffolding (cues to guide the students) to ensure success. Teachers must understand that the formal assessment steps may occur a number of days after the initial introduction of new information and that not every lesson will include all three formal assessment steps.

Exams

Step 6 of the direct instruction lesson requires the students to take an exam or quiz over the content. While exams can take a variety of forms (*e.g.*, essays, multiple choice), several points need to be kept in mind. First, it is prudent to test only the objectives that have been directly taught. This sounds simple, but this principle of effective testing is frequently violated by teachers. Second, test at the appropriate levels of the Bloom taxonomy. Hummel and Huitt (1994) found that over 80% of teacher assessments only require students to perform at the knowledge and comprehension levels, rather than the higher levels of the Bloom taxonomy. Students will not necessarily learn content at the higher levels of the taxonomy unless teachers require them to perform at the higher levels on informal and formal assessments. For example, a teacher might ask students to list and describe the six levels of the Bloom taxonomy, which would only require students to perform at the knowledge or comprehension level. Had the teacher given the students a set of objectives or test items and required the students to explain which level of the taxonomy each item required the student to perform at, the students would be required to perform at the higher levels of the taxonomy. Obviously, students being able to correctly pinpoint which level of the taxonomy requires more time and effort than simply listing the levels in sequence. Last, more frequent assessments over small pieces of content lead to higher levels of student achievement (Gronlund, 1998).

Distributed Practice

Step 7 of the direct instruction lesson is usually thought of as homework but also includes any work students must complete outside of class, such as reports and projects. There are two central points to focus on when making such assignments. First, the assignment is additional practice for content and skills already learned in class. Too many teachers assign homework on new content that requires students to demonstrate skills and knowledge that they have not yet learned. Second, distributed practice assignments should not
only involve practice over new content, but should also help the students to integrate it with content from previous lessons. Frequently, new content is related to, or builds on, information students have already learned. Distributed practice assignments should be designed to connect the new with the old while providing practice over both. For example, in a chronologically based American history class, students may have learned a list of causes that historians believe resulted in World War I. If today's topic in the class deals with the causes of World War II, a distributed practice assignment might require students to describe similarities and differences between the causes of WWI and WWII.

POSITIVE OUTCOMES OF SCRIPTED LESSONS

Research shows that when teachers systematically develop and use scripted direct instruction lessons, several encouraging outcomes can occur. First, students spend more time actively engaged with their subject matter, thereby increasing their achievement (Rieth & Evertson, 1988). Second, students respond correctly at levels more in line with the recommendations for effective instruction such as those provided by the Council for Exceptional Children (1987). In fact, some scripted lessons allow for 4 to 6 responses per minute during instruction and 9 to 12 per minute during practice, demonstrating that effective instruction produces high levels of fluency. Finally, because students respond successfully at such high levels, there are more frequent opportunities for their teachers to attend positively to their correct academic and social responses.

In addition to the benefits previously noted, systematic use of effective instructional practices such as scripted lessons also can decrease misbehavior problems in the classroom. In their review of the literature, Gunter et al. (1998) found that much of the misbehavior exhibited by students may be controlled by negative reinforcement. Specifically, when a lesson is beyond the skill level of students or is presented in a boring or passive way, many students act out (which effectively stops the lesson, at least for a while) to escape the tedium or frustration at not being able to follow the presentation. In numerous studies, when teachers employed effective instructional tactics, the students' rate of misbehavior decreased even though such responses were not directly targeted. Thus, it may be concluded that when instruction is structured so that students respond correctly at high rates, not only will students' achievement increase, but also those misbehaviors that are maintained by negative reinforcement will decrease measurably. When it is important to improve achievement and reduce poor behavior, scripted lessons can be of significant help. (What might help improve achievement and reduce poor behavior? Yes! Scripted lessons can lead to lower levels of misbehavior and higher levels of achievement!)
One criticism of teacher-made scripted lessons that is often also directed to commercially available Direct Instruction materials is that scripts based on complete task analyses of learning objectives are too inflexible. Faster students are viewed as being held back, and slower students may be left behind because the pace is too quick. While either could occur, neither needs to occur.

One of the reasons we first do a task analysis on the learning outcomes is to objectively determine a starting point for the lesson. The starting point should be a skill everyone in the class can do without instruction. The script, then, is simply the pedagogical device of choice that feeds new skills and knowledge piece by piece so the students have enough active participation to thoroughly master the complex behavior specified in the lesson’s objectives.

During a scripted presentation, based on the students’ fluency, teachers can stop at just about any point to provide additional examples and demonstrations, or to discuss specific or extant points possibly requiring greater clarification (based on the students’ responding). Scripts should be designed in enough detail so no student is left behind.

**References**


INTRODUCTION

Applied Behavior Analysis (ABA), Direct Instruction (DI), and Precision Teaching (PT) practices are commonly considered the best practices to serve a variety of learners in special and regular education settings. These fields of study have generated an impressive and substantial list of empirically validated best-practice instructional indicators and procedures utilizing the premises and principles of a natural science approach to understanding and analyzing human learning and teaching (Baer, Wolf, & Risley, 1968, 1987). The Journal of Applied Behavior Analysis, Journal of Direct Instruction, and Journal of Precision Teaching, among many other special and regular education journals, provide ample evidence of this. Despite numerous demonstrations of the validity of these indicators and procedures, most educators do not utilize the curricular design or instructional practices suggested by ABA, DI, or PT (Latham, 1997).

One of the reasons these practices have not been readily adopted and utilized by the broader educational system is that ABA, DI, and PT practitioners
and researchers have not developed a sufficient technology of persuasion (marketing) and dissemination (training and support) (Bailey, 1991). With this in mind, the Competent Learner Model (CLM) was designed as a teacher-friendly approach for the comprehensive transfer and utilization of the principles and procedures of ABA, DI, and PT (Tucci, 1986; Tucci & Hursh, 1991). The intent behind the design of the CLM was to (1) get educators to master the implementation of ABA, DI, and PT best practices, and (2) motivate them to use these practices in their classroom on a daily basis.

The intended outcome of the Competent Learner Model is the development of Competent Learner Repertoires, which allow learning to occur in everyday circumstances within and across school, home, and community settings. For example, a child who asks a store clerk how to find an item is showing herself to be a competent “problem solver” by the fact that she is asking for the information needed to solve a current problem (finding an item). She subsequently shows that she has become a competent listener if she follows the clerk’s directions to the requested item. Basically, a Competent Learner is an individual who can act effectively under novel circumstances—that is, a person who is a capable observer, listener, talker, reader, writer, problem solver, and participant. In learning to implement the CLM, educators master how to arrange instructional conditions that result in the development of repertoires that produce a Competent Learner. In contrast to teaching isolated skills such as color names or shape names, CLM teachers develop learning-to-learn competencies.

Skinner (1953, 1968) has suggested that one of the greatest contributions behavior analysts can make to a person is to set up and manage contingencies that develop repertoires of effective responding. This raises the question, “What repertoires do Competent Learners need when faced with a situation or problem which they have not been explicitly taught to resolve?” When we observe Competent Learners under such situations, we see that they might (1) observe how others respond, (2) listen to suggestions, (3) talk with others, (4) read instructions, (5) write notes, (6) ask for help to solve the problem, and (7) participate until things work out. These are the seven fundamental repertoires utilized by a Competent Learner.

An overview of the CLM (see Fig. 1) shows the connections between these seven repertoires, four key and pervasive instructional conditions, and the possible ways in which the parts of these conditions may be arranged and rearranged to effect learning. As part of its built-in training and support technology, the CLM takes educators through an organized course of study within a personalized system of instruction (see Chapters 12 and 13). As they progress through this curriculum, participants learn about the model’s premises and how to carry out its practices. CLM coaches support participants as they progress through the course of study. Coaching continues until each educator has mastered both content and implementation of the model’s premises and practices. In addition to the coaches, the CLM employs behavior analysts who collaboratively consult with and support educators as they
FIGURE 1
An overview of engineering learning environments according to the Competent Learner Model. (©1997 Tucci Learning Solutions, Inc.)
implement the model's practices within their classrooms. Over the years, we have seen that this type of training and support, once faded, helps create a community of educators who support each other to continue the practices. We have also observed that the integration of ABA, DI, and PT technologies is critical to the success of the CLM.

**APPLIED BEHAVIOR ANALYSIS AND THE COMPETENT LEARNER MODEL**

The Competent Learner Model utilizes best practice recommendations supported by experimental, conceptual, and applied research from Applied Behavior Analysis, Direct Instruction, and Precision Teaching (Tucci, 2003). The structure of the model provides answers to four questions to guide the design of educational programs. These four questions are derived from Skinner's *The Technology of Teaching* (1968).

**What repertoires need to be developed or weakened?**

The obvious starting point in any educational endeavor is to assess what outcomes are needed or desired. The Competent Learner Model does this by assessing the status of each learner's Competent Learner Repertoires (CLRs). Currently, five levels make up the Competent Learner Repertoire assessment (CLRA). Each of these levels assesses various aspects of the seven Competent Learner Repertoires (problem solver, talker, listener, etc.) in terms specific to Skinner's analysis of human verbal (1957) and non-verbal (1953) behaviors. All five CLRAs are designed so they can be completed by anyone who is familiar with the learner. The items of the CLRAs assess (1) whether an aspect of a repertoire is established; (2) if it is established, whether it is exhibited as an approximation or is fully developed; and (3) if it is fully developed, whether it occurs only rarely, frequently, or across all situations where it is appropriate. Example items from the CLRA for naïve learners call for educators or parents to observe whether the learner (1) asks for what he or she wants in an acceptable way throughout the day (a part of the Problem Solver Repertoire), (2) responds correctly when asked questions (a part of the Talker Repertoire), and (3) follows instructions (a part of the Listener Repertoire). Other such questions are answered until a relatively complete profile of the strengths and weaknesses of all of the learner's CLRs is developed. Each item is constructed to assess how the learner performs during various activities typical of most classrooms or homes. The CLRA profile summarizes the learner's CLRs and is used to place the learner in the appropriate level and lesson of the CLM curricula and/or
other curricula that provide a clear scope and sequence for the outcomes they are designed to produce.

**What stimuli are available to effect change in behavior?**

Once it is known which repertoires need to be developed, educators need to know what instructional and reinforcing stimuli (actions or objects) are available to develop or weaken the learner’s repertoires. These include stimuli that the learner will work to (1) gain access to, (2) escape from, or (3) avoid. Knowing which actions or objects already serve as reinforcers or aversives for the learner allows the educator to determine whether there are sufficient stimuli to develop the competent learner repertoires.

**What contingencies are required to develop or weaken the repertoires?**

Through the "arrangement of supplemental contingencies" (Skinner, 1968), the CLM teaches educators to employ available or potentially available instructional and reinforcing stimuli to effect change when the usual curricula and instructional formats are not sufficient to develop a learner’s repertoires. These supplemental contingencies are used only when needed, moving to the support of more natural contingencies as soon as possible. The arrangement and rearrangement of supplemental contingencies assists us in developing the Competent Learner repertoires. The simplest form of a contingency is the relationship between an Antecedent, a Behavior, and a Consequence. This ABC contingency describes the teaching event (Antecedent) intended to cue or precede a specified Behavior, and the events (Consequences) that will follow correct and incorrect responses. For example, a teacher pointing to one of an array of three or more pictures placed on a table in front of a learner constitutes an Antecedent that cues the learner to label (the Behavior) that picture. Teacher praise for correct labeling behavior constitutes a potentially reinforcing Consequence. Within the CLM, this type of a contingency is used to establish and strengthen labeling behavior in the development of the Observer Repertoire. In addition to the ABC contingency, arranging supplemental contingencies involves employing means to establish or enhance the effectiveness of Reinforcers. These types of contingencies are referred to as Establishing Operations (Michael, 1982) and they are used to influence the learner's motivation to become a Competent Learner. One type of Establishing Operation (EO) is to temporarily limit access to preferred activities or materials which results in those activities or materials becoming more valuable as reinforcers. Another type of Establishing Operation is to allow students to have access to materials or activities for an extended period of time and
How can the parts of instructional conditions be arranged and rearranged to develop the competent learner repertoires?

The CLM assists educators in doing this by providing them with the knowledge of what repertoires need to be developed, what stimuli serve as potential reinforcers and aversives, and what contingencies are needed to effectively develop or weaken repertoires. This knowledge can then be combined with the skills needed to effectively arrange and rearrange the parts of instructional conditions, thus arranging and rearranging contingencies that can develop or weaken repertoires. For example, the CLM curriculum for naïve learners includes an instructional format in one of the lessons that describes providing the learner with a task they can reliably do while the educator stays nearby to provide help as needed. This format helps to develop the learner’s Participator Repertoire in semi-directed (e.g., practice or application) instructional conditions.

DIRECT INSTRUCTION AND THE COMPETENT LEARNER MODEL

The CLM curricula are designed to serve naïve learners, particularly those with special needs and learning histories that have made learning in typical learning environments very challenging. The CLM curricula are designed in accordance with the principles that have been the basis for the highly effective DI curricula (Engelmann & Carnine, 1982; Kame‘enui & Simmons, 1990). These principles have been distilled within the CLM to guide teachers in their application and to develop the instructional formats that make up the CLM Curricula (Fig. 2).

All levels of the CLM curricula are compatible with most other curricula and instructional practices because CLM curricula focus on the development of the learning-to-learn repertoires applicable to all learning. The CLM curricula enhance the delivery of other curricula by making conspicuous the contingencies that develop the learner repertoires with any given curriculum content. For example, over the course of many lessons, one of the CLM formats builds a repertoire from having the learner respond to a few teacher instructions in a one-to-one context to having the learner respond to three sets of 10 such instructions in a small group context. This sequence of formats has been designed to establish and strengthen the learner’s Participator Repertoire under teacher-directed instructional conditions, something that is incorporated in many, if not all, other curricula. The tracking sheet for the first 16 lessons of the CLM curricula is provided here to show the kinds of outcomes typically results in those materials and activities becoming less valuable to the learner.
### DESIGNING LESSONS: Summary of Teacher Tasks

<table>
<thead>
<tr>
<th>Design tasks (formats)</th>
<th>Sequence tasks</th>
<th>Schedule time for each task</th>
<th>Specify correction procedures</th>
<th>Design practice tasks (formats)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Identify Knowledge Form</strong></td>
<td>Do not sequence a series of difficult tasks back to back. An example of a possible sequence: easy (firm), easy, hard (new), easy. That is, sequence tasks so that the required schedule of reinforcement is ensured.</td>
<td>Determine the approximate time requirements to teach each task to ensure sufficient time to deal with difficult tasks</td>
<td>Prepare or study correction procedures to respond to learner errors</td>
<td>Design expansion activities so learners can use newly acquired knowledge and skills across instructional conditions (e.g., semi-directed and peer-directed)</td>
</tr>
<tr>
<td>- Verbal associations</td>
<td>- Rules</td>
<td>- Cognitive strategies</td>
<td>- Concepts</td>
<td></td>
</tr>
<tr>
<td><strong>Select Range of Examples</strong></td>
<td>Tasks with highly similar response requirements may cause confusion</td>
<td>- Limited</td>
<td>- Expanded (varied)</td>
<td>- Dissimilar</td>
</tr>
<tr>
<td><strong>Place Examples in Proper Sequence</strong></td>
<td>Review new tasks within the same lesson, i.e., establish a firming cycle</td>
<td>- Similar (e.g., form or sound of letters)</td>
<td>- Dissimilar</td>
<td></td>
</tr>
<tr>
<td><strong>Select &amp; Sequence Test Examples</strong></td>
<td>- Acquisition</td>
<td>- Discrimination</td>
<td>- Retention</td>
<td>- Generalization</td>
</tr>
<tr>
<td><strong>Select &amp; Sequence Practice Examples</strong></td>
<td>- Amount of practice</td>
<td>- Structure of practice</td>
<td>- Schedule of practice</td>
<td>- Student response form</td>
</tr>
</tbody>
</table>

**FIGURE 2**

Direct Instruction design principles distilled for use within the Competent Learner model. (Adapted from Englemann & Carnine, 1982; Kame'enui & Simmons, 1990. © 1995 Tucci Learning Solutions, Inc.)
achieved in the development of various CLRs. In addition, it illustrates how the scope and sequence ensure that learners develop more elaborate and complete CLRs as they progress through the curriculum (Fig. 3).

### FIGURE 3

The scope and sequence of the outcomes accomplished across all the Competent Learner repertoires for the first 16 lessons of the Competent Learner model curricula. (©2004 Tucci Learning Systems, Inc.)
Once something is learned, it is often important to have the learner practice it until the response is fluent (Binder Haughton, Van Eyck, 1990). The measurement process in Precision Teaching (PT) (Lindsley, 1992) is designed to focus educators’ attention precisely on changing the frequency/rate of behavior. This changing frequency/rate is referred to as celeration. Programming for celeration integrates nicely with programming to achieve general case mastery learning because something learned fluently is resistant to being interrupted by distractions or lost by lack of practice. Many of us have not roller skated since we were children; yet, because we became fluent roller skaters then, we will usually do well as a model when our own children convince us to teach them how to roller skate. The CLM incorporates PT practices by integrating fluency practice into the outcomes specified in the CLM curricula and the CLRAs where appropriate. For example, one aspect of the Problem Solver Repertoire for naïve learners is to develop their asking (mand) for something they want so that it is occurring at least 12 times per hour throughout the instructional day. It has been our experience that most naïve learners begin to independently ask for what they want as this frequency/rate of asking is reached. Thus, the fluency aim of 12 per hour for asking is incorporated to ensure that asking is developed as a permanent part of the learner’s Problem Solver Repertoire.

**THE COMPONENTS OF THE COMPETENT LEARNER MODEL**

We consider the components required for full implementation of the CLM to be (1) a course of study for educators and parents; (2) coaching for educators and parents; (3) a systematic and organized curriculum for learners; (4) performance assessments for educators, parents, and learners, and (5) collaborative consultations.

**The CLM Course of Study**

Educators who complete the CLM course of study are coached to master the ABA, DI, and PT aspects of the model and to demonstrate their mastery during performance checkouts following their completion of each of the units in the course. Most of the performance checkouts require the educator to apply what has been learned to one or more of their students in their classrooms. Mastery with respect to each aspect is gained by repeated practice of the skills required to formulate, deliver, and monitor instructional programming for their students. This practice helps to make conspicuous the contingencies that can establish, strengthen, maintain, or weaken the behaviors that comprise the
CLRs. For example, the first three units require educators to accurately assess examples of aspects of the CLRs, set up and deliver an instructional format designed to strengthen one aspect of a CLR, and factually report what they see and hear happening in an instructional interaction. The scope and sequence of the units of phase one of the CLM course of study illustrate how the competencies developed are an integration of the ABA, DI, and PT practices that have been so well supported by applied research over the past 50 years (see Fig. 4).

Each CLM unit has been written by Tucci and associates using the design principles of programmed instruction (Skinner, 1968) and Direct Instruction. Educators read text, view video clips, and answer questions regarding what they have read as a means to evaluate their mastery of the competencies needed to arrange and rearrange parts of instructional conditions so that their learners' CLRs are developed. The range and limits of each tactic are illustrated across successive screens on the CD-ROM. For example, participants see what happens when a rich schedule of reinforcement that has been maintaining a student's participation under teacher-directed instructional conditions is too quickly shifted to a leaner schedule. They are asked to describe what happened, why, and what can be done to improve the situation.

**Coaching**

Coaching is a critical component of the CLM course of study to ensure that each educator is guided as needed to mastery and practices what is learned to fluency. A CLM coaches course has been developed so that those educators who complete the CLM course of study and want to become coaches may do so. The coaches course focuses on those skills necessary for the coach to establish a collaborative relationship with the educators completing the course of study, maintain a positive rapport with them, and provide the coaching necessary for them to function independently of the coach. Having coaches come from among the educators completing the CLM course of study helps to establish a community of educators supporting each other's efforts to apply what they have learned in their own classrooms. It also makes it feasible for that community to grow as school districts then have a corps of coaches to extend the CLM course of study to many classrooms throughout the district.

**Collaborative Consultation**

The core of application of the CLM by behavior analysts is collaborative consultation. The educators who operate the classrooms every day have the experience with their students necessary to identify much of the information needed to answer the four questions that guide educational programming. The CLM provides a framework that assists the behavior analyst in forming a collaborative relationship with the educators. It is within the context of this collaborative relationship that information from the educators' experience
FIGURE 4
The scope and sequence of tasks mastered in phase 1 of the Competent Learner Model course of study.
(© 1997 Tucci Learning Solutions, Inc.)
can emerge and make conspicuous the contingencies operating in the classroom that both support and hinder the development of the CLRs. For example, a behavior analyst who is invited by an educator to assist with a student who consistently disrupts all attempts at establishing teacher-directed instructional conditions can study the case with the educator to determine under what conditions the learner will participate.

Studying the case can mean that the behavior analyst becomes a participant observer in the classroom by recording the ABCs of interactions with the student across instructional conditions and even participates in delivering some of the instructional conditions as they become an accepted part of the environment. In doing so, the behavior analyst can reveal the contingencies in two potentially helpful ways. The ABCs allow the patterns that have been established to emerge while the delivery of some of the instructional conditions allows the educators to see the patterns in action by observing the interactions between the behavior analyst and the student. A behavior analyst who participates in the setting in these ways can consistently call attention to effective practices already in place and make suggestions for practices that are within the educator's repertoire and have a high probability of providing some immediate relief from some aspect of the problem. Thus, the CLM collaborative consultation process is an ongoing functional assessment. The educator, with support from the behavior analyst, assesses the contingencies that are in place, rearranges the contingencies to develop the repertoires, observes the effects, and further rearranges the contingencies as needed.

In this example, the behavior analyst may observe that the student reliably participates in non-directed instructional conditions and that the educator is skilled at offering choices to the students. These two observations can lead to the suggestion that the educator temporarily replace all or almost all teacher-directed instructional conditions with non-directed instructional conditions involving choices for the student among objects or activities that observations have shown are preferred by the student. This is something the educator is likely to be able to do, based on the observations, and it sets up the instructional conditions where the student has been observed to reliably participate. As the educator and student experience success in these arrangements, the Behavior Analyst can suggest that the educator build in short delays between offering choices and the student receiving what was chosen. Eventually, simple teacher-directed tasks can be incorporated within the short delays. This process has some probability of success as it sets up the conditions for the educator to gain value (being useful) with the student, and the behavior analyst to gain value with the educator. Building value among all participants within any setting increases the likelihood of success for any endeavor in that setting. This is the essence of the collaborative consultation process.
EVIDENCE OF THE IMPACT OF THE COMPETENT LEARNER MODEL

The CLM targets development of individual CLRs. Children who undergo programming within the model each have their own program books, which track their progress throughout the curriculum. The Competent Learner Repertoire Assessment is used as both a placement and summary tool within the model. For example, in Fig. 5, a CLRA chart shows the initial and subsequent evaluations of a learner who entered the CLM at 2 years of age. The solid black bars show the learner's profile when he entered the curriculum, and the striped, white bars show his progress over an 8-month period. This profile clearly shows this learner's strengths and challenges and the wide variance of development of his CLRs. As discussed earlier, this interplay of strengths and challenges is

FIGURE 5
Example Competent Learner Repertoire assessments from entry to 8 months later for a naive 2-year-old learner with autism (©2003 Tucci Learning Solutions, Inc.).

RATING SCALE: 0 = No opportunity to observe; 5 = Repertoire mastered & performed consistently; 4 = Repertoire established but requires further development across people, places, and items; 3 = Repertoire established BUT rarely performed across people, places, and items; 2 = Repertoire is established but response form is ONLY approximated; 1 = Repertoire is NOT established.
used to develop an effective learner profile that organizes what is taught, by whom, where, and when. Again, the goal of this organization is to positively affect the value of teaching and learning for the student by managing that student's moment-to-moment experience with response effort, response pay-off (reinforcement), fatigue, boredom, and motivation.

The learner in Fig. 5 started out with absolutely no motivation to interact with adults (other than his parents and close relatives), a very low tolerance for delayed gratification, no emergent speech, and very little sustained attention. At the time of this writing, he is willing to interact with a much broader range of adults, tolerate delays in gratification, produces recognizable one-word and two-word sentences to ask for and describe items (e.g., says, “green” when asked the color of an object), and will participate in extended circle times and other teacher-directed activities.

The CLM assumes as a premise that the CLRs are the core of all learning (Tucci, 1986; Tucci, 2003; Tucci & Hursh, 1994). The development of CLRs may have an augmentative effect on the mastery of subject matter and possibly an exponential effect on day-to-day functioning. The evidence for the impact of the CLM comes from a variety of sources in addition to the extensive support for the ABA, DI, and PT practices that are integrated within the CLM. Implementation of the CLM results in developing learners’ CLRs (Hursh, Tucci, Rentschler, Buzzee, Quimet, 1995). The CLRA produces results that have high inter-observer agreement, are sensitive to change in learners' behavior, and are significantly and positively correlated with measures of day-to-day functional actions (Deem, Hursh, Tucci, 2003). The computer-video interactive format of the CLM course of study is an efficient means to deliver instruction and ensure mastery of the performance outcomes (Hursh, Katayama, Shambaugh, Laitinen, 2001).

Most importantly, the educators served by the CLM have repeatedly succeeded in arranging and rearranging the parts of instructional conditions so that the learners participate in those instructional conditions and progress through their education and often move to less restrictive learning environments at school and in their communities. These successes have been experienced by dozens of teachers and hundreds of learners in regular and special education classrooms serving students with many different diagnoses. It does not matter what the diagnosis, arranging and rearranging the parts of instructional conditions can develop CLRs, and developing CLRs results in learners who function more effectively in everyday situations. The interested reader is encouraged to visit TucciOnline.com for current information and examples of the CLM.

References


Effective Use of Computers in Instruction

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The most important method of education always consisted of that in which the pupil was urged to actual performance.—Albert Einstein

INTRODUCTION

Effective instruction is a multifaceted process, whether the instructor is a human or a computer. First, it is important to assess the learner’s skills so that instructional material can be presented at an appropriate level and the pace of instructional delivery does not proceed too quickly before learning earlier content, nor too slowly so progress to the next level is impeded (Skinner, 1968). The sequencing of material difficulty and the number of examples and non-examples of each concept can affect the learner’s performance. The student must be engaged and attentive. Finally, frequent opportunities to respond to relevant questions with rapid feedback must be available throughout the learning experience (Vargas, 1986).

Having an instructor continuously available to assess each student’s performance and to tailor the pace and content to the student’s learning situation is not possible in a typical classroom. Instruction from a computer can provide these essential components for each individual student effectively and affordably (Skinner, 1963). In this chapter, we explore the types of instructional software, discuss the characteristics of effective programming of instruction, present evidence for the effectiveness of computer-based...
instruction, and explain how you can evaluate the software that you plan to use.

But, what exactly is "computer instruction" and how is it delivered? Benjamin (1988) writes that, "A teaching machine is an automatic or self-controlling device that (a) presents a unit of information, (b) provides some means for the learner to respond to the information, and (c) provides feedback about the correctness of the learner's responses" (p. 704). Today's desktop computer equipped with instructional software is ideally suited to serve as a "teaching machine."

**WHAT ARE THE TYPES OF INSTRUCTIONAL SOFTWARE?**

The three main types of instructional software are tutorial, drill-and-practice, and simulation. Each of these types is well suited for attaining a particular kind of learning objective. The learning objectives can focus on declarative knowledge ("knowing that") or procedural knowledge ("knowing how"). Declarative knowledge includes learning facts (e.g., "whales are mammals") while procedural knowledge includes motor skills (e.g., typing), problem-solving techniques (e.g., solving differential equations), and procedures (e.g., learning to use a word processor). The instructor should select the type of instructional software that corresponds with the instructional objectives.

**Tutorial**

Tutorial programs are commonly used types of software. Tutorials present the learner with new instructional material, test the learner's knowledge of that material, and provide feedback for responses (e.g., Harrington & Walker, 2002; Jenny & Fai, 2001). Thus, tutorials are ideally suited for teaching declarative knowledge but can also be used for procedural knowledge. For instance, Grant et al. (1982) developed a tutorial, which is available on the Internet (see http://psych.athabascau.ca/html/prtut/reinpair.htm), to teach the concept of positive reinforcement. A recent empirical evaluation of Grant's tutorial found that students' performance improved compared to that of a control group (Grant, 2004). Tutorials may also supplement regular instruction to facilitate learning. Flora and Logan (1996) evaluated the effectiveness of computerized study guides with a general psychology class and found an increase in exam scores when they were used.

**Drill-and-Practice**

Fluency, one characteristic of expertise in an area, is measured by accuracy and speed of responding (Yaber & Malott, 1993). Drill-and-practice programs focus
on building fluency with the learning material. Questions concerning some topic are presented, and the speed of the student's responses and the number of questions successfully answered within a set time period are measured. Yaber and Malott (1993) empirically evaluated the effectiveness of drill-and-practice software (ThinkFast) to teach fluency with behavioral concepts and terms. Student performance on quizzes was enhanced when using the ThinkFast software that contained fill-in-the-blank questions. In another example of drill-and-practice, Washburn (1999) described software wherein students were presented with research reports and were required to discriminate facts from interpretations with simple correct or incorrect statements given as feedback. Initial evaluations of 100 students' performance revealed improvement in scores.

**Simulations**

A simulation program is a model of a realistic situation in which the learner can respond and receive feedback. Lee (1999) classified simulations according to practice, presentation, or presentation hybrid functions. Practice simulations are those that follow other instruction and allow students to apply what they have learned. Presentation simulations teach new material through interaction with the program only. This type of simulation teaches through learning by discovery. The hybrid is a combination of instruction and simulation in which the program provides instruction followed by practice. Lee (1999) found that practice simulations are especially effective and that pure presentation simulations may not be effective. Thus, simulations are best suited for teaching or reinforcing procedural knowledge. Simulations may also provide integration of existing skills in lifelike contexts with the ultimate purpose of promoting generalization of learning to natural situations (Thomas & Hooper, 1991).

There are several possible advantages to using simulations. In learning conditions that are difficult to construct, expensive, or unsafe, instructors may favor use of a simulation approach. Moreover, simulation software may deliver more naturally occurring consequences for the behavior (e.g., graphed data of simulated client behaviors) than can be given with traditional instruction.

Desrochers and Hile (1993) describe the Simulation in Developmental Disabilities: SIDD multimedia software in which the clinical decision-making skills required to treat individuals with severe problem behaviors and mental retardation/developmental disabilities are practiced. Both formative evaluations (Desrochers & Hile, 1993) and experimental studies (Desrochers, Clemmons, Grady, Justice, 2000, 2001) suggest that SIDD can be an effective method of providing students with practice in behavioral principles and procedures. Moreover, SIDD can serve as a useful addition to the standard lecture format to present information regarding functional assessment (Desrochers, House, & Seth 2001).

Gorrell and Downing (1989) conducted an experiment to evaluate the effectiveness of computer simulations representing realistic classroom
situations with undergraduate educational psychology students. The computer simulation group performed better on an application test compared to control, extended lecture, and problem-solving groups. There was no difference in performance on a general knowledge test among these groups, which supports the idea that simulation software might be more effective at teaching procedural knowledge than declarative knowledge.

Computer simulations can also decrease the amount of time spent learning to respond in the actual situation of interest. For instance, Taylor et al. (1999) measured the transfer savings (amount of time needed for learning to criterion for control versus simulation conditions) with aviation software. The researchers found substantial savings in course completion time for the computer-based instruction group who received a comprehensive flight-training program compared to a control group wherein training was provided in an airplane.

**WHAT ARE THE FEATURES OF EFFECTIVE INSTRUCTIONAL SOFTWARE?**

Key design features of effective instructional software include: (1) use of effective antecedents, information given before the student’s response; (2) opportunities for active and frequent student responding; and (3) delivery of feedback regarding student answers. Each of these areas is addressed separately.

**Antecedents for Desired Behavior**

A variety of antecedents may influence learning. Use of instructions, presenting information to prompt the desired behavior, and adaptive instruction have been studied in computer-based instruction research.

**Instructions**

Are instructions necessary for learning to occur? It depends on the instructional situation. Learning can occur with or without the use of words as antecedents (Baum, 1994; Skinner, 1969). Usually the antecedent will be a verbal or textual instruction, which basically specifies a “rule” regarding the correct behavior and its consequences. People follow rules due to past rule-following behavior producing favorable results. Behavior can also gradually develop from being influenced by its consequences. Such behavior is said to be **contingency shaped**. Declarative knowledge is easily acquired through the use of rules, which drill-and-practice and tutorial software approaches can help develop. Procedural knowledge may be developed through rules or by contingency shaping, which simulations may foster. Moreover, learning may occur more quickly when rules are presented as compared to being contingency
shaped. Learning may be enhanced when instructional objectives, which may serve as a prompt or rule for further learning, are presented to the learner. For example, organization of material has been shown to facilitate verbal learning, and learners may impose their own structure (subjective organization) when it is absent (Sternberg, 1996). Structured overviews may also result in students spending more time with instructional software and having more positive attitudes toward it (Brinkerhoff, Klein, & Koroghlanian, 2001).

**Prompting and Fading**

To facilitate new behaviors, prompting and fading of prompts can be embedded in instructional programs. Skinner (1961) described this procedure as a "vanishing" technique, whereby critical information is presented and then gradually removed as the learner performs the desired behavior. Examples of prompts include highlighted text, additional information presented on the screen, or "hint" information. It is important that these features added to the learning situation (e.g., highlighted text) be removed so that interference with later occurrence of the behavior learned does not take place. Research has suggested that prompting may be effective for initial learning (Bannert, 2000; Hall & Borman, 1973), and some research suggests that the more prompts that are embedded in computer-assisted instruction to teach math skills to second-grade students, the better the outcome (Noell, Gresham, & Ganze, 2002).

**Adaptive Instruction**

Can learning be enhanced by tailoring instruction to the student's response? Using this approach to automated instruction, repeated assessments of the student's knowledge is required to determine the content of instruction. Several studies have shown that adaptive instruction does not seem to affect student learning or test scores but does decrease time it takes to learn the material (Litchfield, Driscoll, & Dempsey, 1990; Murphy & Davidson, 1991).

**Behavior: Active and Frequent Student Responding**

How can students be involved in the learning situation? A main advantage of computer-aided instruction over traditional methods of instruction is that students can be individually engaged with and actively responding to the learning material (Vargas, 1986). Furthermore, using response rate as the objective of instruction, as in the case of drill-and-practice software, may promote response maintenance, resistance to distraction, and generalization (Binder, 1993). Student performance is facilitated when computer-based instruction is interspersed with open-answer or fill-in-the-blank questions (i.e., a constructed response) (Kritch, Bostow, & Dedrick 1995; Thomas & Bostow, 1991). Given the apparent beneficial effects of using a constructed-response format during
automated instruction, an important question is whether learning is enhanced by computer-based instruction that includes multiple-choice questions alone or constructed-response questions intermixed in the learning material. A recent study compared the effectiveness of multiple-choice versus constructed-response versus a combined-question format when used to teach a computer-based vocabulary lesson. The results suggested a combination of multiple-choice questions along with the constructed-response method was most effective (Clariana & Lee, 2001). It may be that a multiple-choice format provides a prompt for selection of the correct response, which is further solidified by requiring the student to subsequently type the correct answer.

**Consequences: Feedback for Student Responses**

How can consequences for student responses facilitate learning? A major advantage associated with computer-aided instruction is that feedback can be presented immediately after the student’s response (Anderson Kulhavy, & Andre, 1971; Kulhavy, 1977). This feedback may serve an instructive function or present a rule to the student, both of which affect future responding to similar questions. Researchers have examined various feedback procedures for multiple-choice questions used in computer-based tutorial software. In general, effective procedures include the computer giving the correct answer after one attempt at answering a question or reviewing questions and answers at the end of the unit. Less effective procedures are when no feedback is given or “No, try again” is presented until a correct response occurs (Clariana, 1990; Clariana, Ross, & Morrison 1991).

**WHAT MAKES SOFTWARE DESIGN EFFECTIVE?**

Consideration of design is critical for instructional software as it provides the context in which learning takes place (Park & Hannafin, 1993). Hannafin and Hooper (1989) note that the purposes of screen design (also known as graphical user interface, or GUI) are to stimulate interest, facilitate responding to the instructional material, and promote navigation through the software. Proper GUI also promotes acquisition, retention, and generalization of learning material. Software features that may influence these functions include: (1) navigational aids; (2) presentation style and organizational structure; (3) distinctiveness of information; and (4) text characteristics.

**Navigational Aids**

A major difficulty learners can have is navigating through the computer-based material (Kinzie & Berdel, 1990). To reduce this difficulty, online or supplemental written, audio, or visual materials can be used to indicate where the user is in the
software program. Navigation aides can include highlighting or checkmarks beside completed items to signify what path has been previously selected or providing a flow-chart depiction of the structure of the software. Another method is to provide an initial orientation to navigation in the software and how information is to be presented (e.g., where the Help option is, how to move forward or go back, or what to consult for assistance with the material).

**Presentation Style and Organization Structure**

The presentation format for screen design should be clear and complete enough such that the user is not bogged down with learning how to use the software and can focus on learning the material (Lohr, 2000). Particularly because use of educational software often occurs during one session, it is essential that learning to use the software occur as quickly as possible to maximize lesson time. Consistent presentation of information and readily identifiable cues that signal particular information help the user attend to the relevant information and may facilitate learning the instructional material (Lohr, 2000). Grabinger (1993) examined the readability and "studyability" of screens. He found that organization (e.g., specific areas related to certain functions, use of spacing between paragraphs, single-spaced and double-column text) and stimulation of visual interest (e.g., use of lines, boxes, and illustrations and placement of white space along the margins of the screen) were important criteria for positive judgments by users. Orientation to material can also be achieved by manipulating placement, color, and style of information presented on the screen (Aspillaga, 1996). For instance, to enable quick discrimination, similar information can be grouped together on the screen and separated from other categories (namely, use of Gestalt principles of similarity and proximity) (Szabo & Kanuka, 1998).

**Distinctiveness of Information**

Although important information should be distinctive (e.g., color, size, separation from other information, location) for optimal user responding (Bravo & Blake, 1990), this tactic should be used sparingly so that habituation does not occur (Aspillaga, 1996).

**Text Characteristics**

A general rule of thumb is that the less text on the screen, the better in terms of speed and user satisfaction (Morrison, Ross, & O'Dell, 1988); however, students may also prefer high-density of text on screens due to the increased contextual support it provides (Morrison, Ross, O'Dell, Schultz, & Higginbotham-Wheat, 1989). One solution is to have both high versus low-text options available and let the user select which is preferred. Other general text
characteristics are that the text should be (1) presented in upper and lower case rather than just uppercase letters; (2) a large font, especially if older users are involved; (3) set in contrasting colors (e.g., black on white); and (4) designed to have the focus of information in the center line of vision where visual acuity is sharpest. There is also research to suggest that hypertexted information (highlighted terms that, when selected, provide additional information) neither facilitates nor hampers learning of material (Brown, 1998). Additionally, research has found that accuracy in learner responding increases when navigation information is placed at the top and left of the screen compared to the right and bottom positions (van Schaik & Ling, 2001).

In summary, an effective computer screen design will result in the learner moving easily through the software and being provided with cues to respond quickly to, and should assist in the attainment of educational goals (Lohr, 2000). Whether screen design is effective can be measured by observing users interacting with the software, surveying users’ preferences for software features, and administrating objective performance tests with outcomes compared before and after learning or between users and non-users.

WHAT IS THE EVIDENCE FOR THE EFFECTIVENESS OF AUTOMATED INSTRUCTION?

The use of computers in instruction has been evaluated in hundreds of individual studies. The typical procedure for evaluating automated instruction has the following features: A number of students at some level would be assigned to one of two groups to learn some new content and would receive feedback in some manner. Each group might have a different teacher, but one would use computers in some manner (experimental group) and the other would not (control group). After some period of instruction, the students would be evaluated on some test of knowledge (perhaps a standardized test). If the experimental group with computers scored significantly higher than the control group without computers, then the use of the computers would be deemed possibly beneficial. Due to the difficulties of doing research in the real world of education, stronger conclusions are usually avoided. The results would then be published in some publicly available source.

While such studies have consistently shown that computers improve learning to some extent, there are considerable differences in the outcomes due to the many differences in the methods among these studies. Some of these important procedural differences were italicized in the previous paragraph. Simply put, some procedures reliably produce larger improvements due to computer use than others.

It is important to understand the magnitude of improvements due to computerized instruction that can be expected and the educational significance of those improvements. Meta-analysis, a statistical technique for combining the results of many studies, has been used by several researchers to
estimate the effectiveness of using computers in instruction (Khalili & Shashaani, 1994; Kulik, 1994; Kulik & Kulik, 1987, 1991; Lee 1999). The power of meta-analysis is that it can determine not only an average effectiveness but also provide a basis for finding which type of software is better and how much better.

The basic datum for a meta-analysis is the "effect size" found in an individual study. Effect size* is a measure of the improvement in test scores produced by using computer-based instruction compared to not using it. The major benefit of expressing outcomes in effect sizes is that results of all studies are comparable. Thus, the average effect size can be determined from a large number of studies with very different procedures. Furthermore, by selecting only studies with a particular procedure (e.g., drill and practice), the average effectiveness of that procedure can be determined and then compared to the effectiveness of other procedures (e.g., simulations).

A key consideration when performing a meta-analysis is determining which studies will be included in the analysis. Some criteria for inclusion are established and then the studies are collected. For example, the use of a search phrase such as "computer-based instruction" is entered in a database. All retrieved articles are then screened further for inclusion. An obvious criterion for including an article is the availability of proper data for calculating effect size. Other criteria might focus on academic level of students (e.g., only college students) or content area (e.g., only science instruction). As a result of these selection criteria, different meta-analyses will produce different average effect sizes.

**Meta-Analytic General Results**

Kulik (1994) summarized the findings of 12 published meta-analyses of computer-based instruction. The average effect size of all meta-analyses was 0.35 with a low value of 0.22 and a high value of 0.57. Thus, average effect size has been consistently positive among all of these meta-analyses. The average effect size of 0.35 might seem to be a modest gain, but two points must be considered. First, an effect size of 0.35 might be educationally and socially important. When interpreting this effect size, over 13% of the students who exhibit below-average achievement without computer-based instruction would achieve above-average scores with computer-based instruction. When you consider the large number of students that could be involved in just one school

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* Effect size is the difference in the means between the experimental and control groups divided by the standard deviation. For example, suppose two groups are formed and one uses computer simulations to supplement the lecture and the other group does not. They are then tested with a standardized test as a criterion measure. If the control group averages 50 and the experimental group averages 53.5 with a standard deviation of 10, then the effect size is (53.5 - 50)/10 = 0.35. Or, saying it another way, the experimental group scored 0.35 standard deviations above the control group.
system, a shift of 13% in the population toward higher scores could mean hundreds or even thousands of additional students scoring above average due to the addition of computers in instruction. If begun early enough, such improvements could result in dramatically lower dropout rates and overall greater success in education. In college courses, it could mean more than one letter grade in a course. Second, some of the studies that were selected may have used computers inappropriately or with an ineffective software design; however, if the study met the criteria for inclusion, it would be averaged in regardless. This point will be explored more in the next sections, where more specific criteria for inclusion are used. Some of the differences among studies relate to instructional considerations, such as type of computer application, duration of instruction, student level, feedback, and subject area.

**Specific Meta-Analytic Findings**

Some of the various types of computer applications have been discussed above. The meta-analyses have found that some applications produce bigger effects sizes than others, but these values depend upon which studies are included. For example, Khalili and Shashaani (1994) found that the average effect sizes were 0.11 for drill and practice, 0.26 for tutorial, and 0.79 for simulation. Kulik and Kulik (1991) found 0.31 for computer-aided instruction, 0.37 for computer-managed instruction (used for testing, recordkeeping, and guidance to material), and 0.26 for computer-enriched instruction (presents exercises, demonstration, etc., to motivate students). Kulik (1994) found 0.38 for tutorial (which included drill-and-practice this time), 0.14 for computer-managed instruction, 0.10 for simulation, and 0.14 for computer-enriched instruction. These results show that the type of application must moderate a general statement about effectiveness.

Lee (1999) explored meta-analyses for simulations in much more detail and found the following effect sizes: 0.54 for practice, -0.01 for presentation, and 0.48 for the hybrid. Thus, even within a type of application, such as simulation, there can be tremendous variability in effect sizes that can be isolated by more refined meta-analyses. Azevedo and Bernard (1995) performed a meta-analysis on the effects of feedback. They found that with immediate testing, feedback produced an effect size average of 0.80 compared to no feedback; with delayed testing, feedback had an average effect size of 0.35.

How do these effect sizes compare with other teaching techniques? Educators have many innovative techniques available to improve learning in their students. A decision on the use of computers should be compared to the other techniques. Kulik (1994) gathered results from various meta-analyses on other innovations in education so that direct comparisons could be made. He further statistically corrected for differences that can obscure outcomes. For comparison purposes computer tutorials had effect size of 0.48, accelerated classes were 0.93, classes for gifted were 0.50, and peer-tutoring
procedures were 0.38. These results indicate that computer tutorials are relatively effective while not being limited to a select student population.

**HOW SHOULD PARTICULAR INSTRUCTIONAL SOFTWARE BE EVALUATED?**

It is essential that pedagogical validity be considered when designing and evaluating automated instructional software. Pedagogical validity is the extent to which an instructional procedure leads students to achieve the instructional objectives. Applied to computer-based instruction, pedagogical validity is the extent to which (1) the intended instructional content is included, (2) desired performance outcomes are attained, and (3) learning generalizes. Instructional software should be developed with a clear definition of instructional content, learning outcomes, and methods to enhance generalization. The decision to use a particular software package should ultimately be based on the software's pedagogical validity and a match between the software design and the instructional requirement.

**Content**

The instructional content could be as sweeping as a stand-alone course or as limited as a brief demonstration to supplement other teaching methods. Some methods used to determine whether instructional goals are adequately met include expert evaluation of the software domain (Desrochers & Hile, 1993) and comparison of the instructional material with standard knowledge in that area (Desrochers, Hile, Williams-Moseley, 1997).

**Outcomes**

As previously discussed, the learning outcomes may be declarative knowledge, procedural knowledge, or fluency. The type of student outcome that is desired will influence the design and selection of the software. For declarative knowledge, tutorials would be the preferred type. For procedural knowledge, a practice or hybrid type of simulation would be appropriate. For building fluency, drill and practice would be the preferred option.

**Generalization**

When a student can perform learned responses in new situations, we can say the behavior has generalized. Stimulus generalization may involve examining whether the correct response occurs to different teachers, materials, or test questions (for example, whether the student engages in the problem-solving procedures taught when presented with a new problem). Behavior
generalization refers to whether the student emits a new behavior, other than that taught by the instructional device. For instance, behavioral generalization would occur if teaching students to produce examples of concepts results in them producing new variations along that theme. Moreover, it is important to ensure that information is retained or that student gains persist long after training has ended.

CONCLUSIONS

Automated instruction has come a long way since Pressey (1926) and Skinner (1958) first introduced their teaching machines. Much research has been conducted to elucidate the critical features of effective teaching machines. We have learned that computer-based instruction can be generally effective; however, to ensure that the particular instructional software is having its intended effect, assessment of pedagogical validity is essential. Providing the student with instructions and prompts, requiring frequent and active responding, and delivering immediate feedback are major factors contributing to effective automated instruction (Vargas, 1986). Additionally, research has shown that screen design can directly and indirectly (e.g., through attitudes) impact learning. See Table 1 for a list of considerations to guide selection of automated instructional software.

The future bodes well for automated instruction. Technology is advancing at a tremendous pace providing the exciting possibility for new methods of automated instruction. For instance, computers that accurately recognize

<p>| TABLE 1 |</p>
<table>
<thead>
<tr>
<th>A Checklist of Considerations for Selection of Instructional Software</th>
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<tbody>
<tr>
<td>✓ Is assessment of student behavior frequent and used to guide instruction?</td>
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<tr>
<td>✓ Are the instructional procedures effective?</td>
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<tr>
<td>• Are antecedents effectively used to promote learning?</td>
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<tr>
<td>• Are effective instructional objectives presented?</td>
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<tr>
<td>• Are navigation aides provided?</td>
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<tr>
<td>• Is assistance or prompts for the desired behavior given? Are prompts gradually faded?</td>
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<tr>
<td>• Is instruction adaptive or geared to the individual student?</td>
</tr>
<tr>
<td>• Is frequent and active student responding required?</td>
</tr>
<tr>
<td>• Is immediate feedback delivered?</td>
</tr>
<tr>
<td>✓ Is pedagogical validity adequately addressed?</td>
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<tr>
<td>• Do the goals of the software match the instructional purpose?</td>
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<tr>
<td>• Is new material taught through tutorial method?</td>
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<tr>
<td>• Is fluency tied to drill-and-practice?</td>
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<tr>
<td>• Is practice in application of concepts or behaviors taught through use of simulations?</td>
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<tr>
<td>• Does the student learn the desired skills or knowledge?</td>
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<tr>
<td>• Do the learning gains occur across stimuli, behaviors, and time?</td>
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speech are on the horizon. Speech recognition teaching machines may be used to develop desired verbal behaviors that are found in the student's natural environment, and this development should lessen generalization concerns. Similarly, use of virtual reality environments with three-dimensional representation of images may also facilitate learning gains. The closer the appearance of training materials to those found in the natural environment, the more likely generalization of responding will occur. No matter the technology employed, it is essential that empirical evaluations of the instructional software provide the foundation for decisions regarding its use.

References


