# The Taxonomy of Learning and Behavioral Fluency

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*Instructional design refers to "the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation" (Smith & Ragan, 2005, p. 4). Said differently, instructional design represents how one will structure learning for success. While this may seem like a straightforward proposition, many factors influence instructional design and how an instructional designer engineers effective learning programs.*

Morrison, Ross, and Kemp (2007) shared a comprehensive list of factors under their taxonomy of instructional design functions that include identifying instructional problems using needs assessment, goal analysis, and performance assessment; analyzing the learner and the context in which learning will occur; conducting a comprehensive task analysis that includes doing a topic analysis, procedural analysis, and using the critical incident method; creating objectives and using an expanded performance content matrix; sequencing learning; addressing strategies that facilitate recall, integration, organization, and elaboration; designating preinstructional strategies such as pretest, objectives, overviews, and advance organizers as well as the message design through signals and pictures; developing instructional materials; using formative, summative, and confirmative evaluation and assessing various standards of achievement and use of student self-evaluation; testing for knowledge items, skills and behavior, and attitudes; planning the proposal, project, and then management; and implementing the plan or program and making decisions.

While all consumers of learning materials should understand the many factors of instructional design in order to make thoughtful selections of instructional programs and curricula, instructional design reminds Precision Teachers of an important relationship: "What teachers teach is just as important as how it is taught . . . having a clear understanding of what is taught ultimately helps the teacher decide how it should be taught" (Kameenui & Simmons, 1990, p. 58).

*Precision Teaching and Behavioral Fluency*

White (2005) defined Precision Teaching similarly as "a system for defining instructional targets, monitoring daily performance, and organizing and presenting performance data in a uniform manner to facilitate timely and effective instructional decisions" (p. 1433). Lindsley (1992) also described Precision Teaching as a comprehensive system of measurement: "Precision teaching is basing educational decision on changes in continuous self-monitored performance frequencies displayed on 'standard celeration charts.' Twenty-five years of practice . . . have produced a set of tools, methods, rules, and procedures for making these decisions. High performance aims and custom-tailored prescriptions maximize learning" (p. 51).

While Precision Teaching, as a comprehensive system, offers more than a method for understanding and achieving behavioral fluency, behavioral fluency nonetheless has taken a prominent role in education, psychology, and behavior analysis. Lindsley (1997) not only deemed behavioral fluency the "core of Precision Teaching practice" but also recognized it as one of Precision Teaching's major discoveries

(1990, 1992).

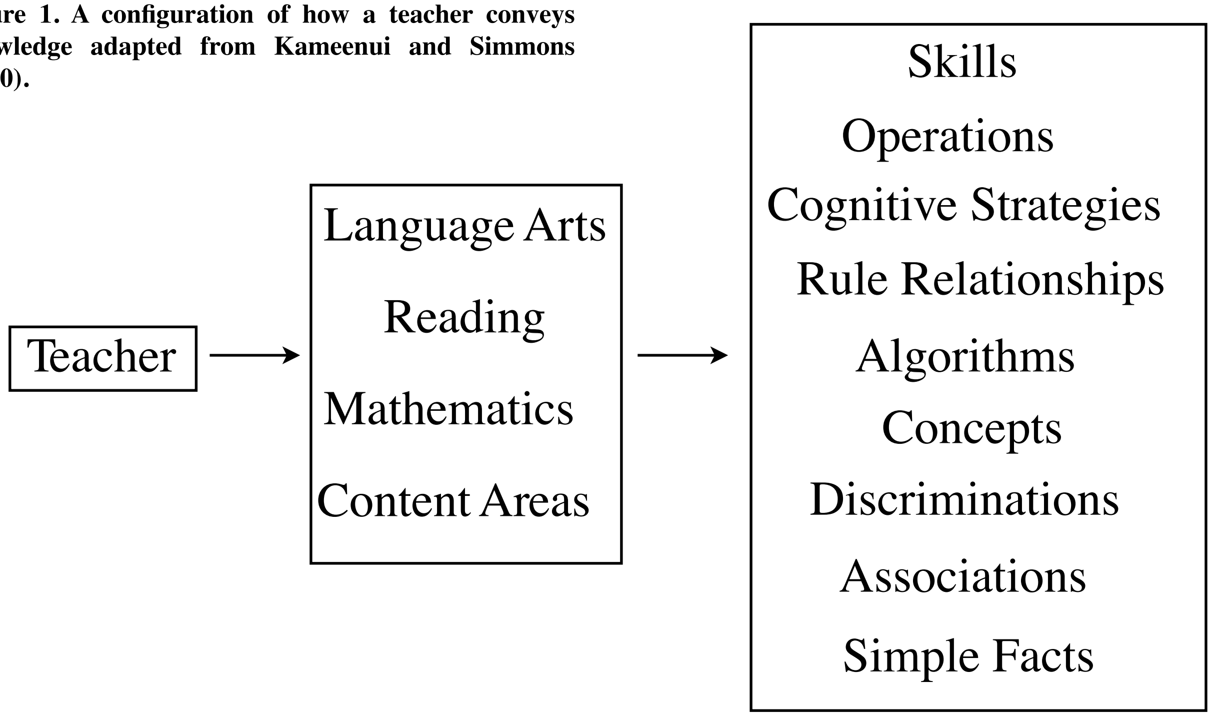
Behavioral fluency posits that the attainment of performance standards, or frequency ranges of behavior, has associated critical learning outcomes. "The effects define fluency in the same way that the effects define reinforcement" (Lindsley, 1996, p. 212). Behavioral fluency has three effects or associated outcomes: retention, endurance, and application (Binder, 1996, 2005; Haughton, 1980, 1982). Retention refers to "the ability to perform a skill or recall knowledge long after formal learning programs have ended, without re-teaching in school year after year"

(Binder, Haughton, & Bateman, 2002, p. 4). For example, a study by Kubina, Amato, Schwilk, and Therrien (2008) demonstrated that students who read a passage to a high frequency aim (i.e., performance standard) when compared to reading to a lower frequency aim had comparable decrements in retention. During a 3-month retention measure, however, the students who read the passage to the performance standard had higher reading frequencies than students who read passages to the lower frequency aim.

Endurance refers to the ability to attend to a specified task for a given length of time and in the presence of environmental distractions (Binder, 1984, 1996, 2005). Binder, Haughton, and Van Eyk (1990) provided an example of endurance when they examined the effects of endurance on writing fluency. Seventy-five students ranging from kindergarten through eighth grade wrote digits from 0-9 as quickly as possible. Students wrote for intervals of 15 sec, 30 sec, 1 min, 2 min, 4 min, 8 min, or 16 min. The results showed that students who wrote at a frequency of 70 responses per minute performed similarly across all writing intervals. Students who could not write as quickly had increasing decrements in their performance when they had to write for longer intervals.

Another effect of fluency, application, means that one or more behavioral elements can combine with another element or elements to form a behavioral compound (Barrett, 1979; Binder, 1996, 2005; Haughton, 1972, 1980). A study by Bucklin, Dickinson, and Brethower (2000) demonstrated application by randomly assigning participants to one of two groups: an accuracy-only group or a fluency group. The participants practiced the two behavioral elements (i.e., Seeing Hebrew symbols and writing associated nonsense syllables, and seeing nonsense syllables and writing associated Arabic numbers). When given the compound behavior, reading arithmetic problems written in Hebrew symbols and writing answers in Arabic numerals,

**Figure 1. A configuration of how a teacher conveys knowledge adapted from Kameenui and Simmons (1990).**



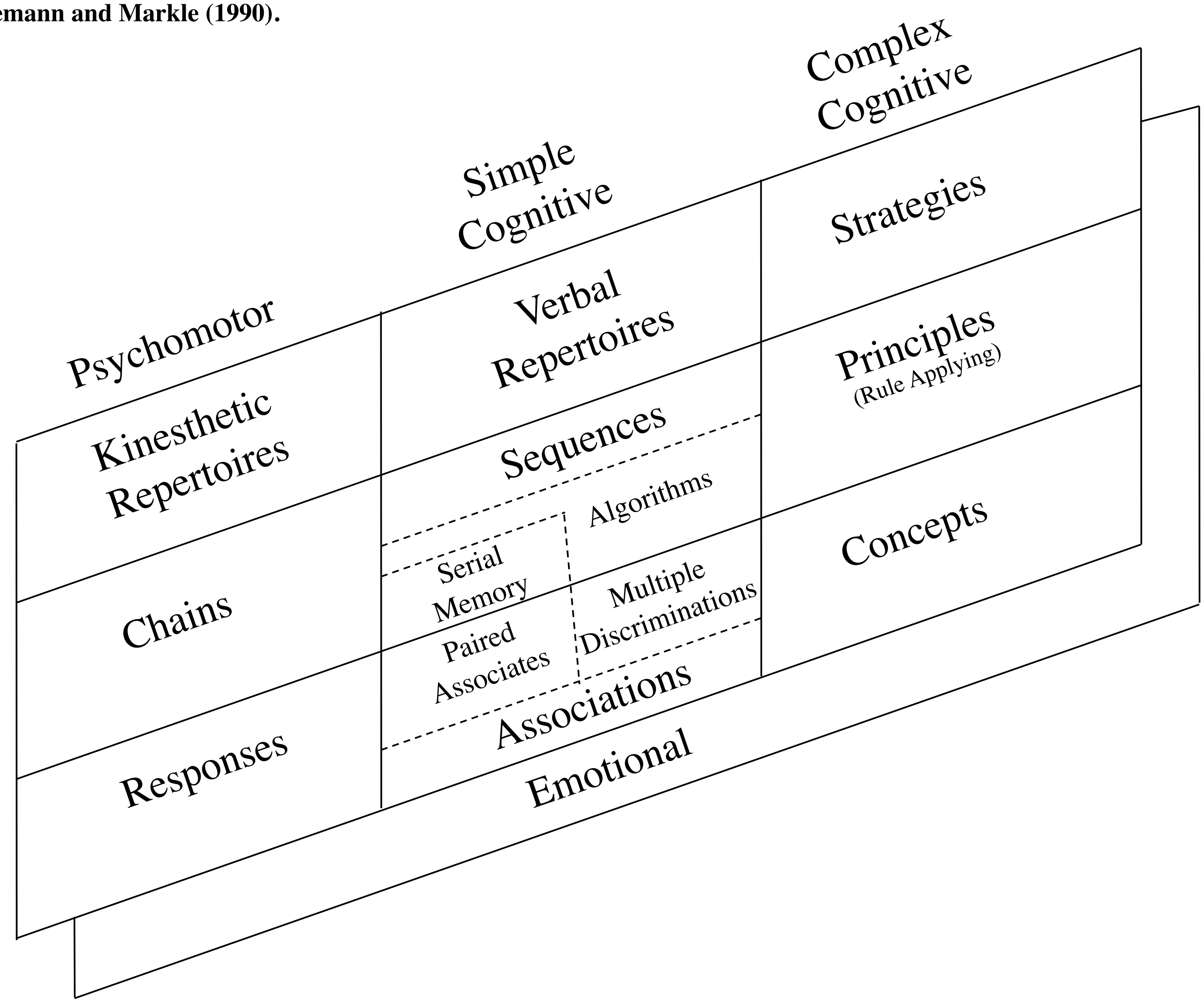
participants in the fluency group completed more items than the accuracy-only group, reaching the threshold of statistical significance. Additionally, when the element behaviors were measured, the participants in fluency group demonstrated statistically significant retention compared to the accuracy only group.

A database spanning more than 35 years and 33 research articles supports the behavioral fluency theory that attaining performance standards has associated effects, namely, retention, endurance, and application (Kubina, 2010). While a large number of studies exist to support the specific notion that behavioral fluency has associated effects, many other studies show the importance and usefulness of fostering fluent behavior. A study by Bell, Young, Salzberg, and West (1991), for example, helped high school students with and without disabilities pass the written maneuvers portion of their driver education class. Students received a combination of direct instruction, peer tutoring, and practice to fluency monitored with Precision Teaching.

Behavioral fluency also has support at the organizational level of individual classrooms and schools, showing dramatic academic achievement outcomes (Beck & Clement, 1991; Johnson & Layng, 1994; Johnson & Street, 2004; Kubina, Commons, & Heckard, 2009; Maloney, 1998; Spence, 2002). Johnson and Street (2004) captured the goal of practice when they wrote: "The goal of fluency building is to build hardy academic behaviors—behaviors that weather periods of no practice, occur with short latencies, are impervious to distraction, and are easily accessible in new situations" (p. 30).

As with abundant studies either measuring the associated effects of fluency (i.e., retention, endurance, application) or showing how fluent performances help learners accomplish a goal,

**Figure 2. A taxonomy of learning as described by Tiemann and Markle (1990).**



behavioral fluency occurs as a result of practice (Kubina, 2005b). The theory of behavioral fluency indicates that a learner will engage in practice until meeting a predetermined performance standard, at which point effects of fluency appear (Kubina, 2010). While the Precision Teaching literature does not advocate a preferred method for practice, some models argue for adopting a systematic routine that encompasses timed practice, corrective feedback, positive reinforcement, and daily decision making informed by Standard Celeration Charted data (Kubina, 2005a; Kubina & Yurich, 2009).

*Behavioral Fluency and Designing Instructional Content*

While a much expanded article may ask how Precision Teaching can interface with instruction, the present article asks more narrowly what role behavioral fluency plays during the instructional process. A structural analysis of knowledge helps to answer such a question. The structural analysis helps explain teaching that could involve explaining, directing, defining, communicating, or describing, all of which involve imparting information (Kameenui & Simmons, 1990). The information could involve a rule, idea, fact, operation, concept, or other forms of knowledge (Kameenui & Simmons, 1990).

Figure 1 shows an adapted configuration of such a structural analysis of how a teacher conveys knowledge. The far left box represents a teacher who may teach from any of the following curricular areas, language arts, reading, mathematics, and from content areas (the middle box). The box to the far right shows that each of the curricular areas contains different forms of knowledge ranging from an association (e.g., in reading seeing an s and saying the sound ssss) to a cognitive strategy (e.g., in science using the scientific method in an experiment).

A mathematics teacher may wish to instruct a student to discriminate among three numbers. To best teach discriminations, the teacher would identify the form of knowledge and offer instruction conductive to the particular form of knowledge (i.e., multiple discriminations). For instance, a teacher might present three numbers such as 2, 5, and 8, which the student would discriminate. Instruction could involve a plan for introducing new numbers through modeling (e.g., Stein, Kinder, Silbert, & Carnine, 2006, format 5.1). A teacher would write a numeral on the board and then directly model the identification of each. For instance, pointing to a 2, the teacher would say, "This is a 2. What is this?" The student would respond by saying "2." After modeling each individual numeral, the teacher would write all three numerals on the board and ask the student to respond each time the teacher touched a different numeral. Once the student can say each numeral correctly in the presence of the other two numerals, the student has learned to discriminate among 2, 5, and 8.

Conversely, if the teacher wanted to teach word problems, he or she might choose to use a different instructional tactic for the problem solving. Therefore, teachers should carefully select different instructional designs to properly convey various forms of knowledge. Gagné (1965) first classified the many forms of knowledge a teacher might use and called them the "varieties of learning." Gagné identified eight types of learning: signal learning, stimulus-response learning, chaining, verbal associations, multiple discriminations, concept learning, principle learning, and problem solving. While Gagné would later refine his concepts, others such as Tiemann and Markle (1990) further extended the different forms of learning.

*Tiemann and Markle's Taxonomy of Learning*

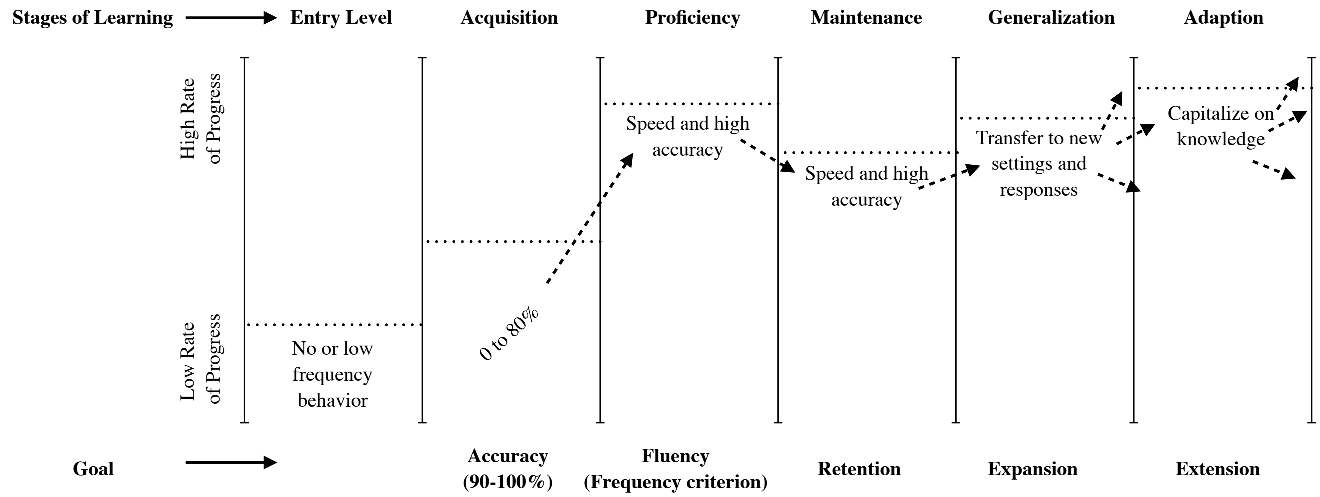
Figure 2 shows the classification system created by Tiemann and Markle (1990). The three-dimensional taxonomy has four basic types of learning; three columns, Psychomotor, Simple Cognitive, and Complex Cognitive, appear on top of the fourth type of basic learning, Emotional. Emotional learning underlies all of the other categories to remind teachers that whenever people learn something, whether simple or complex, a level of physiological arousal also co-occurs (Tiemann & Markle, 1990). Emotions experienced by the person can cover the full spectrum of feelings from mild amusement and excitement to abounding frustration or panic. A groan from a student each time the teacher announces math instruction offers insight into the emotional learning that has already transpired.

The other three types of learning range across an encompassing tract of human learning, each of

**Table 1. Definitions of the basic types of learning and the subcategories in taxonomy of learning**

| Basic Type of Learning | Definition | Example(s) |
|---|---|---|
| Emotional Learning | Reacting to an antecedent stimulus with a private event or inner behavior (the involuntary reaction to the stimuli). Emotional learning can manifest itself through observable, visible actions or may remain private. | Inner feeling (unobservable): Anger, anxiety, fear, boredom, and happiness. Observable behavior (inner feeling): Face turning red (anger), excessive sweating (anxiety), looking away from instruction (boredom), and smiling (happiness). |
| Psychomotor Learning | Any single or multiple physical response(s). Expressed by the voluntary control and movement of muscles in a precise way. | Cleaning up blocks, setting a table, flossing one's teeth, shuffling cards, playing an oboe. |
| Psychomotor Learning Subcategories | | |
| Responses | Performing a single motor behavior. | Twisting a door knob, turning on a light switch, picking up a small marble, erasing the board. |
| Chains | Connection of multiple motor responses in a sequence to form a complex or chained response. | Drawing a face by drawing eyes, ears, nose, mouth, and hair, tethering a boat using a clove hitch. |
| Kinesthetic Repertoires | A collection of responses and chains occurring in the presence of the appropriate stimuli. | Engaging in a racquetball volley with forehands, backhands, and ceiling shots. Driving a truck in traffic (shifting gears, looking at mirrors, speeding up and slowing down). |
| Simple Cognitive Learning | Basic stimulus-response relations, sequences, and expansive/detailed verbal repertoires. | Reciting addition facts, recalling a friend's phone number, telling a fable. |
| Simple Cognitive Learning Subcategories | | |
| Associations | In the presence of a stimulus, the individual makes an appropriate response. | Recognizing a person's name when seeing his/her face, seeing color "red" and saying "red," hearing and then singing the "A" note. |
| Paired Associates | A set of responses made to a set of stimuli. | Naming all classmates, naming all of the primary colors, identifying and saying nonsense syllables. |
| Multiple Discriminations | Discriminating differences between two or more stimuli. | Identifying a smile in a picture with two other pictures showing a frown and no expression, picking out a hot dog with other sandwiches on a table. |
| Serial Memory | Responding to a particular stimulus by producing a series of associations in specific sequence. | Reciting the alphabet in order, rote counting from 1 to 100, singing the lyrics for "Twinkle, Twinkle, Little Star." |
| Algorithms | Following a sequence-dependent step-by-step procedure. | Solving multidigit multiplication problems, sorting values for data analysis. |
| Sequences | Producing a set of sequential responses for an activity. | Following the steps to bake a cake, assembling a model. |
| Verbal Repertoires | Acquiring many different types of associations and sequences producing a large verbal repertoire. | Discussing U.S. presidents and recounting notable events with specific years, sharing major contributions, and describing personal information not widely known. |
| Complex Cognitive Learning | The individual applies and integrates previous learning to new contexts. | Applying a note-taking strategy in a different class, predicting the stock market using finance rules. |
| Complex Cognitive Learning Subcategories | | |
| Concepts | A set of stimuli in which all members share the same characteristics. | Learning that "fish" includes tuna, redfish, groupers, and trout. |
| Principles | A rule that sets a relationship between two or more concepts. | Fish, amphibians, reptiles, birds, and mammals are all vertebrate animals. If an animal has a backbone, it is a vertebrate animal. |
| Strategies | A series of multistep associations and procedures that can include any psychomotor, simple, or complex cognitive skills to deal with a new situation. | Placing animals into correct categories using the knowledge of fish and principles of invertebrate and vertebrate anatomy. |

**Figure 3. The stages of learning adapted from Smith (1981).**



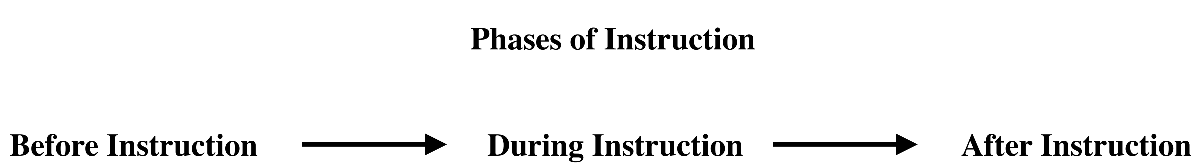

which further divides into multiple levels and also associates with one another. For example, simple to complex physical behaviors constitute the Psychomotor Learning column. Simple stimulus-response relations to complex and expansive verbal repertoires make up the Simple Cognitive column, whereas instances in which the learner now must produce functional responses to new stimuli represent the Complex Cognitive column. Table 1 provides full definitions and examples of each type of basic learning and the components.

Teaching and forms of knowledge. As suggested previously, understanding the classifications or types of learning allows the teacher to better design instruction. Consider an example of a response from the psychomotor column: writing a letter. Elementary education teachers start teaching students to write letters in kindergarten and first grade. The proper formation of a letter calls for proper posture, pencil gripping, and producing consistent and legible strokes. By understanding task analysis and the unique contribution of each single response, a teacher would use procedures tailored for teaching letter writing. For example, a tripod grasp of a pencil along with circular and vertical marks leads to making a lowercase *d*.

Teachers also take into account the form of knowledge with simple cognitive behaviors such as paired associations. Science teachers may have a chapter learning objective of naming five influential physicists during the 20th century, their contributions, and dates of research. A paired association instructional approach would follow. Students first learn the association between Enrico Fermi and nuclear chain reactions in the 1910s, then Einstein and the theory of relativity in the 1920s, and so on, continuing with different combinations of physicists, contributions, and dates. Once mastered, later instruction may involve multiple discriminations among physicists, specific contributions, and years.

A teacher's understanding of strategies, the apex of the complex cognitive column, can lead to the attainment of sophisticated student behavior. A student's inability to resolve conflicts, for instance, presents serious problems for all involved: the student, peers, and the teacher. A strategy of

**Figure 4. The three phases of instruction adapted from Kameenui and Simmons (1990).**



conflict resolution includes a set of actions that adapt to the environmental resources to achieve social benefits. Therefore, teaching such a strategy involves multiple components. The teacher may focus first on the student's ability to identify body language or more overt responses indicating a problem situation. The teacher would also instruct behaviors such as speaking calmly and walking away. By bringing other children and adults into role playing or natural situations, the teacher can further evaluate functionality and generality of such conflict resolution strategy.

By matching instruction to the form of knowledge, teachers can design more appropriate lessons in conveying skills/concepts of interest. In addition to such a direct benefit, the taxonomy of learning also helps teachers diagnose learning problems and make instructional decisions to meet students' needs. Take the example of an algorithm for multidigit multiplication. The standard algorithm for solving problems follows:

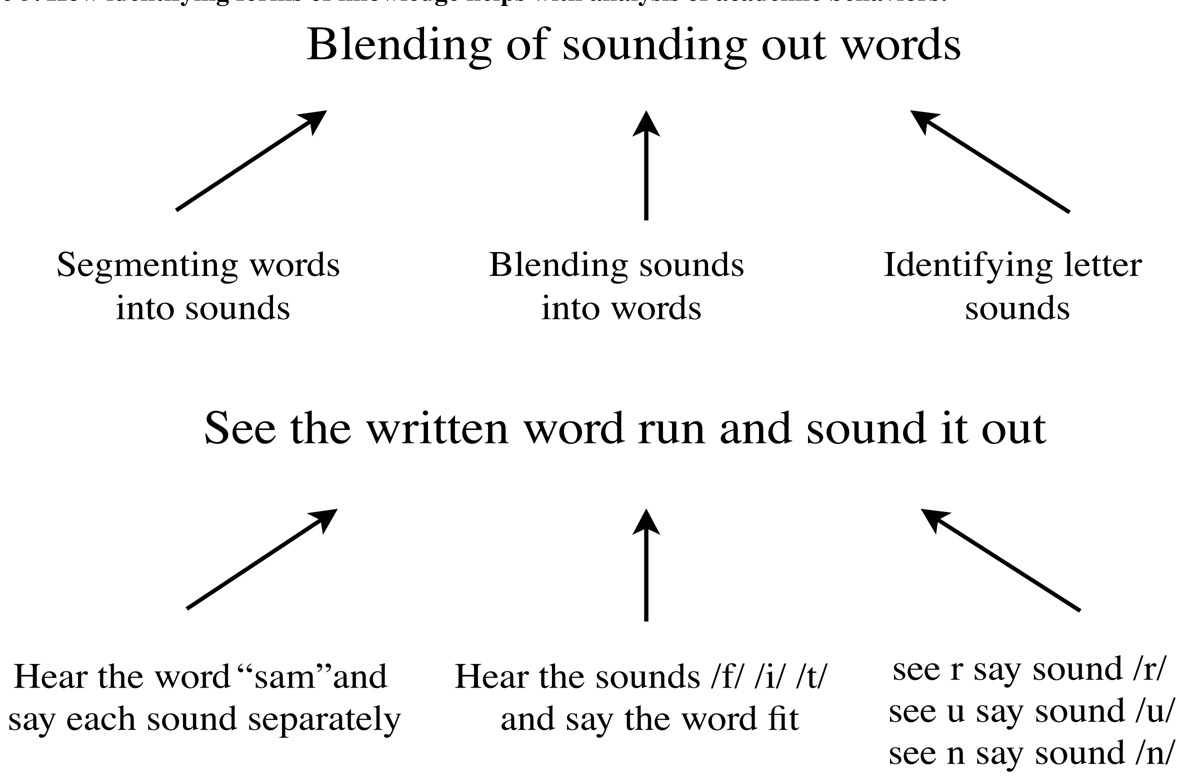
| | | | | |
|---|---|---|---|---|
| | | 2 | 3 | 4 |
| | X | | 5 | 9 |
| | 2 | 1 | 0 | 6 |
| 1 | 1 | 7 | 0 | |
| 1 | 3 | 8 | 0 | 6 |

For students having difficulty with the algorithm, performance of paired associates (e.g., numbers and quantity), multiple discriminations, (e.g., numerals), and algorithms (e.g., addition) will shed light on how to better help the student. Through error analysis, a teacher can identify what aspect of knowledge his or her student experiences difficulties with and therefore respond properly. In such an example, if a student struggles to apply an algorithm, the teacher can look at how well the student has learned addition and multiplication facts, and how well the student has the constituent forms of knowledge necessary for learning the new multi-digit multiplication.

*Stages of Learning*

Regardless of the targeted form of knowledge, each type of learning proceeds through stages as shown in Figure 3 (adapted from Mercer and Mercer, 2005, in line with design techniques suggested by Tufte, 2006). At the top of the figure each stage has its name. Parallel to the stages, at the bottom, each stage has a specific goal. At the far right, moving from the bottom of the figure to the top indicates the rates of progress. A behavior such as factoring trinomials at the entry level would mean the student exhibits a low rate of progress toward learning.

**Figure 5. How identifying forms of knowledge helps with analysis of academic behaviors.**



On the other hand, a student who quickly and accurately factors trinomials, a proficient behavior, demonstrates a high rate of learning progress.

The first stage shows the entry level where the behavior occurs at a very low frequency or not at all. A student with entry level behavior for letter sounds may know the sounds of /s/ and /m/ but not know the other 40 beginning sounds (cf. Carnine, Silbert, Kame'enui, & Tarver, 2010). Some form of instruction follows entry level behavior, and the student progresses to the acquisition stage of learning. The student who is learning letter sounds may receive instruction with a teacher modeling, leading, and testing for acquisition of the selected letter sounds. The acquisition stage culminates with the goal of highly accurate behavior.

After a student has met the criteria for the acquisition stage, learning shifts to the next stage, called proficiency. Proficiency, like acquisition, also has a terminal goal to indicate that the student has met the goals of the stage. Engaging in a behavior that has high degrees of accuracy but also occurs with speed or at the appropriate frequency represents fluency (Binder, 1996, 2005). After the student meets the criteria for the proficiency stage, he or she moves on to maintenance, generalization, and then adaptation.

The stages of learning depict learning as a multifarious, not a unitary, process. Learning does not manifest itself as traditionally held with a two-way exchange of information in which a teacher speaks and a student listens. Examining the rich tapestry of learning reveals an intricate fabric of different types of learning held together by the weaving of the different stages of learning. The recognition and discovery of the effects of behavioral fluency by Precision Teachers points to the importance of practicing a behavior to fluency. Within the context of the stages of learning, behavioral fluency fosters retention, which leads to maintenance. Additionally, a behavior maintained through time can also become available for generalization. And studies showing the increased likelihood of application (e.g., Bucklin, Dickinson, & Brethower, 2000; Chiesa & Robertson, 2000; Kubina, Young, & Kilwein, 2004) lend themselves to the adaption stage of learning.

*Behavioral Fluency and the Taxonomy of Learning*

A large amount of information from Precision Teaching has demonstrated the validity of behavioral fluency. Kubina (2010) found 33 peer-reviewed studies in which performance standards occurred with either retention, endurance, application, or a combination thereof. While Precision Teaching has much to offer the teaching profession, the specific discovery of behavioral fluency appears particularly well-suited for classroom application. The possibility of designing instruction via a taxonomy of learning and fostering behavioral fluency holds great promise for teachers.

The findings of behavioral fluency intersect the taxonomy of learning when considering the phases of instruction. The three distinct stages of instruction, as shown in Figure 4, direct a teacher to effectively respond before, during, and after instruction (Kameenui & Simmons, 1990). The before phase has 15 features that include defining, designing, managing, and modifying and adapting instruction. During instruction, the teacher still manages instruction but also delivers and modifies his or her teaching. After instruction, a teacher assesses instruction, decides if further modifications and adaptations need to occur, and manages, transfers, and reflects in the instruction. Kameenui and Simmons (1990) offer a full and detailed description of the three phases. The remainder of this article will focus on how behavioral fluency and the taxonomy of learning can come together in the three phases of instruction.

All three phases of instruction pertain mainly to the acquisition stage of learning. Using the three phases of learning, however, does also have relevance for maintenance, generalization, and adaptation to varying degrees. Behavioral fluency, and practice in general, cements the information learned in the acquisition stage. Therefore, scheduling practice to performance standards belongs in the before phase of instruction. The form of knowledge scheduled for the practice routine then influences the lesson planning. If practicing multiple discriminations of letter sounds, a teacher needs a practice sheet with the targeted sounds displayed on the page. If practicing chains, such as the square dance moves taught in gym class, the teacher may develop a mnemonic rhyme to help students memorize the proper steps. In the before phase of instruction, the teacher not only painstakingly crafts instruction but also pays close attention to how students will practice the specific behavior to a performance standard.

The critical learning outcome of behavioral fluency also has relevance for the before, during, and after instruction phases. Application refers to the process element behaviors combining to form a compound behavior (Barrett, 1979; Binder, 1996, 2005; Haughton, 1972, 1980). An application study by Lin and Kubina (2004) demonstrated the relationship of skill elements and a compound behavior. For the study, 157 fifth-grade students wrote answers to basic multiplication problems for 1 min and then complex multiplication problems for 1 min. The resulting correlation of .75 between the skill element basic multiplication facts and the skill compound complex multiplication facts highlighted the importance of fluency; skill competence with an element behavior greatly predicted skill competence with the compound behavior.

For the before instruction phase, instructional planning, understanding what elements consist of or, more specifically, how skill elements fit into a taxonomy of learning, allows teachers to harness the full analysis of a compound skill. Figure 5 shows how different types of learning or skill elements can combine to form compound behavior. A student who can blend letters into a word, or sound out a word, engages in an algorithm. The step-by-step procedure calls for the student to see a word made up of letters and to say each letter sound in a left-to-right order. The algorithm will allow the student to decode the word "fit" by seeing the f and saying the sound for f, then i and saying the sound for i, and concluding with t and saying the sound for t. The student must say the f and i for one to one and a half seconds and the t for only a fraction of a second.

Teaching in the course of the During Instruction phase has teachers presenting instruction at a brisk pace, using clear signals for responses, providing thinking time before responses, and presenting in an enthusiastic manner (Kameenui & Simmons, 1990). The recommendations for presenting the information mostly concern helping students acquire the selected content. Therefore, a student learning paired associates such as letter sounds would benefit from all of the instructional delivery recommendations. Behavioral fluency would most directly affect the practice phase taking place either after, or concurrent with, the teaching of letter sounds.

The recommendations for After Instruction affected by behavioral fluency fall within "transferring instruction." One suggestion speaks to generalization and asks if the newly acquired skill occurs in different contexts. Teachers must plan for generalization and foster it during the initial teaching and subsequent practice of a form of knowledge. A great many tactics lead to attainment of such effect (Cooper, Heron, & Heward, 2007). Take the example of serial memory. A student reciting dialogue for a play may acquire the lines in the room of the drama club teacher. But also practicing the lines in different rooms and ultimately on the play with the props of the play fosters generalization. Furthermore, practicing the lines to fluency in a generalized setting increases the probability that the behavior will occur as desired.

The other goal for transferring instruction calls for scheduling practice via independent seatwork. Kameenui and Simmons (1990) have the teacher determine if the student has met the teacher-specified criterion of performance. But with behavioral fluency, a student will practice any form of knowledge until he or she meets the objective performance standard or fluency aim. The performance standard for letter sounds, paired associates, reported in practice and research falls within the 100–120 letter sounds per minute range (Freeman & Haughton, 1993; Kubina, Commons, & Heckard, 2009). Students will then practice until they meet the performance standard for letter sounds instead of relying on more subjective teacher-imposed criteria.

*Conclusion*

Precision Teaching can augment any curriculum. While Precision Teaching offers some insight into instructional design (e.g., Lindsley, 1997), understanding a taxonomy of learning will also lead the Precision Teacher to more carefully create, modify, or refine instructional and/or practice materials. In addition, when students practice and achieve behavioral fluency, the taxonomy of learning clearly defines what the students have achieved competence with and what they may need to practice next.

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