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Types of Instruction

Because some forms of thinking—critical thinking, creativity and problem solving—are broad and important educationally, it is not surprising that educators have identified strategies to encourage their development. Some of the possibilities are shown in Table 1 and are grouped into two categories: how much the strategy is student-centered versus teacher-centered. It should be emphasized that the classifications in Table 1 are not very precise, but they give a useful framework for understanding some of the options available for planning and implementing instruction.

Table 1

Student-centered	Cooperative learning, Inquiry, Discovery learning, Self-reflection, Independent study
Teacher-centered	Advance organizers, Lectures, Direct instruction, Madeline Hunter's "Effective Teaching", Taking notes

Table 2 below defines some of the terms used in Table 1:

Table 2 Definitions of Terms in Table 1

Lecture	Telling or explaining previously organized information—usually to a group
Advance organizers	Brief overview, either verbally or graphically, of material about to be covered in a lecture or text
Taking notes	Writing important points of a lecture or reading
Madeline Hunter's "Effective Teaching"	A set of strategies that emphasizes clear presentation of goals, the explanation and modeling of tasks to students and careful monitoring of students' progress toward the goals

Facilitating complex thinking: Teacher-directed instruction

As the name implies, teacher-directed instruction includes any strategies initiated and guided primarily by the teacher. A classic example is exposition or lecturing (simply telling or explaining important information to students) combined with assigning reading from texts. But teacher-directed instruction also includes strategies that involve more active response from students, such as encouraging students to elaborate on new knowledge or to explain how new information relates to prior knowledge. Whatever their form, teacher-directed instructional methods normally include the organizing of information on behalf of students, even if teachers also expect students to organize it further on their own. Sometimes, therefore, teacher-directed methods are thought of as transmitting knowledge from teacher to student as clearly and efficiently as possible, even if they also require mental work on the part of the student.

Lectures and readings

Lectures and readings are traditional staples of educators, particularly with older students (including university students). At their best, they pre-organize information so that (at least in theory) the student only has to remember what was said in the lecture or written in the text in order to begin understanding it (Exley & Dennick, 2004). Their limitation is the ambiguity of the responses they require: listening and reading are by nature quiet and stationary, and do not in themselves indicate whether a student is comprehending or even attending to the material. Educators sometimes complain that "students are too passive" during lectures or when reading. But physical quietness is intrinsic to these activities, not to the students who do them. A book just sits still, after all, unless a student makes an effort to read it, and a lecture may not be heard unless a student makes the effort to listen to it.

Advance organizers

In spite of these problems, there are strategies for making lectures and readings effective. A teacher can be especially careful about organizing information *for* students, and she can turn part of the mental work over to students themselves. An example of the first approach is the use of **advance organizers**—brief overviews or introductions to new material before the material itself is presented (Ausubel, 1978). Textbook authors (including ourselves) often try deliberately to insert periodic advance organizers to introduce new sections or chapters in the text. When used in a lecture, advance organizers are usually statements in the form of brief introductory remarks, though sometimes diagrams showing relationships among key ideas can also serve the same purpose (Robinson, et al., 2003). Whatever their form, advance organizers partially organize the material on behalf of the students, so that they know where to put it all, so to speak, as they learn them in more detail. Organizers that are generated by students are not advance organizers because they are creating the organizer while they are learning (i.e., not in advance of instruction).

Recalling and relating prior knowledge

Another strategy for improving teacher-directed instruction is to encourage students to relate the new material to prior familiar knowledge. When one of us (Kelvin) first learned a foreign language (in his case French), for example, he often noticed similarities between French and English vocabulary. A French word for picture, for example, was *image*, spelled exactly as it is in English. The French word for *splendid* was *splendide*, spelled almost the same as in English, though not quite. Relating the French vocabulary to English vocabulary helped in learning and remembering the French.

As children and youth become more experienced in their academics, they tend to relate new information to previously learned information more frequently and automatically (Goodwin, 1999; Oakhill, Hartt, & Samols, 2005). But teachers can also facilitate students' use of this strategy. When presenting new concepts or ideas, the teacher can relate them to previously learned ideas deliberately—essentially modeling a memory strategy that students learn to use for themselves. In a science class, for example, she can say, "This is another example of…, which we studied before"; in social studies she can say, "Remember what we found out last time about the growth of the railroads? We saw that…"

If students are relatively young or are struggling academically, it is especially important to remind them of their prior knowledge. Teachers can periodically ask questions like "What do you already know about this topic?" or "How will your new knowledge about this topic change what you know already?" Whatever the age of students, connecting new with prior knowledge is easier with help from someone more knowledgeable, such as the teacher. When learning algorithms for multiplication, for example, students may not at first see how multiplication is related to addition processes which they probably learned previously (Burns, 2001). But if a teacher takes time to explain the relationship and to give students time to explore it, then the new skill of multiplication may be learned more easily.

Elaborating information

Elaborating new information means asking questions about the new material, inferring ideas and relationships among the new concepts. Such strategies are closely related to the strategy of recalling prior knowledge as discussed above: elaboration enriches the new information and connects it to other knowledge. In this sense elaboration makes the new learning more meaningful and less arbitrary.

A teacher can help students use elaboration by modeling this behavior. The teacher can interrupt his or her explanation of an idea, for example, by asking how it relates to other ideas, or by speculating about where the new concept or idea may lead. He or she can also encourage students to do the same, and even give students questions to guide their thinking. When giving examples of a concept, for example, a teacher can hold back from offering all of the examples, and instead ask students to think of additional examples themselves. The same tactic can work with assigned readings; if the reading includes examples, the teacher can instruct students to find or make up additional examples of their own.

Mastery learning

This term refers to an instructional approach in which all students learn material to an identically high level, even if some students require more time than others to do so (Gentile, 2004). In mastery learning, the teacher directs learning, though sometimes only in the sense of finding, writing, and orchestrating specific modules or units for students to learn. In one typical mastery learning program, the teacher introduces a few new concepts or topics through a brief lecture or teacher-led demonstration. Then she gives an ungraded assignment or test immediately in order to assess how well students have learned the material, and which ones still need help. The students who have already learned the unit are given enrichment activities. Those needing more help are provided individual tutoring or additional self-guiding materials that clarify the initial content; they work until they have in fact mastered the content (hence the name *mastery learning*). At that point students take another test or do another assignment to show that they have in fact learned the material to the expected high standard. When the system is working well, all students end up with high scores or grades, although usually some take longer to do so than others.

As you might suspect, mastery learning poses two challenges. The first is ethical: is it really fair to give enrichment only to faster students and remediation only to slower students? This practice could deteriorate into continually providing the fast with an interesting education, while continually providing the slow only with boring, repetitious material. In using the approach, therefore, it is important to make all materials interesting, whether enrichment or remedial. It is also important to make sure that the basic learning goals of each unit are truly important—even crucial—for everyone to learn, so that even slower individuals spend their time well.

The other challenge of mastery learning is more practical: the approach makes strong demands for detailed, highly organized curriculum. If the approach is to work, the teacher must either locate such a curriculum, write one herself, or assemble a suitable mixture of published and self-authored materials. However the curriculum is created, the end result has to be a program filled with small units of study as well as ample enrichment and remedial materials. Sometimes providing these practical requirements can be challenging. But not always: some subjects (like mathematics) lend themselves to detailed, sequential organization especially well. In many cases, too, commercial publishers have produced curricula already organized for use in mastery learning programs (Fox, 2004).

Direct instruction

Although the term *direct instruction* is sometimes a synonym for *teacher-directed instruction*, more often it refers to a version of mastery learning that is highly scripted, meaning that it not only organizes the curriculum into small modules or units as described above, but also dictates *how* teachers should teach and sometimes even the words they should speak (Adams & Engelmann, 1996; Magliaro, Lockee, & Burton, 2005). Direct instruction programs are usually based on a mix of ideas from behaviorism and cognitive theories of learning. In keeping with behaviorism, the teacher is supposed to praise students immediately and explicitly when they give a correct answer. In keeping with cognitive theory, she is supposed to state learning objectives in advance of teaching them (providing a sort of mini-advance organizer), provide frequent reviews of materials, and check deliberately on how well students are learning. Direct instruction usually also introduces material in small, logical steps, and calls for plenty of time for students to practice.

Direct instruction programs share one of the challenges of other mastery learning approaches: because they hold all students to the same high standard of achievement, they must deal with differences in how long students require to reach the standard. But direct instruction has an additional challenge, in that they often rely on small-group interaction more heavily than other mastery learning programs, and use self-guiding materials less. This difference has the benefit that direct instruction works especially well with younger students (especially kindergarten through third grade), who may have limited skills at working alone for extended periods. The challenge is that reliance on small-group interaction can make it impractical to use direct instruction with an entire class or for an entire school day. In spite of these limits, however, research has found direct instruction to be very effective in teaching basic skills such as early reading and arithmetic (Adams & Engelmann, 1996).

Madeline Hunter's effective teaching model

A number of direct instruction strategies have been combined by Madeline Hunter into a single, relatively comprehensive approach that she calls **mastery teaching** (not to be confused with the related term *mastery learning)* or the **effective teaching model** (M. Hunter, 1982; R. Hunter, 2004). Important features of the model are summarized in Table 3. As you can see, the features span all phases of contact with students—before, during, and after lessons.

Table 3 Madeline Hunter's "Effective Teaching Model" *Source*: R. Hunter, 2004

Prepare students to learn. • Make good use of time at the beginning of a lesson or activity, when attention is best • Direct students' attention to what lies ahead in a lesson—for example, by offering "advance organizers" • Explain lesson objectives explicitly
Present information clearly and explicitly. • Set a basic structure to the lesson and stay with it throughout • Use familiar terms and examples • Be concise
Check for understanding and give guided practice. • Ask questions that everyone responds to—for example, "Raise your hand if you think the answer is X" • Invite choral responses—for example, "Is this a correct answer or not?" • Sample individuals' understanding—for example, "Barry, what's your example of X?"
Provide for independent practice. • Work through the first few exercises or problems together • Keep independent practice periods brief and intersperse with discussions that offer feedback

What happens even before a lesson begins? Like many forms of teacher-directed instruction, the effective teaching model requires curricula and learning goals that are tightly organized and divisible into small parts, ideas, or skills. In teaching about photosynthesis, for example, the teacher (or at least her curriculum) needs to identify the basic elements that contribute to this process, and how they relate to each other. With photosynthesis, the elements include the sun, plants, animals, chlorophyll, oxygen produced by plants and consumed by animals, and carbon dioxide that produced by animals and consumed by plants. The roles of these elements need to be identified and expressed at a level appropriate for the students. With advanced science students, oxygen, chlorophyll, and carbon dioxide may be expressed as part of complex chemical reactions; with first-grade students, though, they may be expressed simply as parts of a process akin to breathing or respiration.

Once this analysis of the curriculum has been done, the Hunter's effective teaching model requires making the most of the lesson time by creating an **anticipatory set**, which is an activity that focuses or orients the attention of students to the upcoming content. Creating an anticipatory set may consist, for example, of posing one or more questions about students' everyday knowledge or knowledge of prior lessons. In teaching about differences between fruits and vegetables, the teacher could start by asking: "If you are making a salad strictly of fruit, which of these would be OK to use: apple, tomato, cucumber, or orange?" As the lesson proceeds, information needs to be offered in short, logical pieces, using language as familiar as possible to the students. Examples should be plentiful and varied: if the purpose is to define and distinguish fruits and vegetables, for example, then features defining each group should be presented singularly or at most just a few at a time, with clear-cut examples presented of each feature. Sometimes models or analogies also help to explain examples. A teacher can say: "Think of a fruit as a sort of 'decoration' on the plant, because if you pick it, the plant will go on living." But models can also mislead students if they are not used thoughtfully, since they may contain features that differ from the original concepts. In likening a fruit to a decoration, for example, students may overlook the essential role of fruit in plant reproduction, or think that lettuce qualifies as a fruit, since picking a few lettuce leaves does not usually kill a lettuce plant.

Throughout a lesson, the teacher repeatedly **checks for understanding** by asking questions that call for active thinking on the part of students. One way is to require all students to respond somehow, either with an actual choral response (speaking in unison together), another way with a non-verbal signal like raising hands to indicate answers to questions. In teaching about fruits and vegetables, for example, a teacher can ask, "Here's a list of fruits and vegetables. As I point to each one, raise your hand if it's a fruit, but not if it's a vegetable." Or she can ask: "Here's a list of fruits and vegetables. Say together what each on is as I point to it; you say 'fruit' or 'vegetable', whichever applies." Even though some students may hide their ignorance by letting more knowledgeable classmates do the responding, the general level or quality of response can still give a rough idea of how well students are understanding. These checks can be supplemented, of course, with questions addressed to individuals, or with questions to which individuals must respond briefly in writing. A teacher can ask everyone, "Give me an example of one fruit and one vegetable", and then call on individuals to answer. She can also say: "I want everyone to make a list with two columns, one listing all the fruits you can think of and the other listing all the vegetables you can think of."

As a lesson draws to a close, the teacher arranges for students to have further **independent practice**. The point of the practice is not to explore new material or ideas, but to consolidate or strengthen the recent learning. At the end of a lesson about long division, for example, the teacher can make a transition to independent practice by providing a set of additional problems similar to the ones she explained during the lesson. After working one or two with students, she can turn the rest of the task over to the students to practice on their own. But note that even though the practice is supposedly “independent”, students’ understanding still has be checked frequently. A long set of practice problems therefore needs to be broken up into small subsets of problems, and written or oral feedback offered periodically.

What are the limits of teacher-directed instruction?

Whatever the grade level, most subjects taught in schools have at least some features, skills, or topics that benefit from direct instruction. Even subjects usually considered “creative” can benefit from a direct approach at times: to draw, sing, or write a poem, for example, requires skills that may be easier to learn if presented sequentially in small units with frequent feedback from a teacher. Research supports the usefulness of teacher-directed instruction for a variety of educational contexts when it is designed well and implemented as intended (Rosenshine & Mesister,1995; Good & Brophy, 2004). Teachers themselves also tend to support the approach in principle (Demant & Yates, 2003).

But there are limits to its usefulness. Some are the practical ones are pointed out above. Teacher-directed instruction, whatever the form, requires well-organized units of instruction in advance of when students are to learn. Such units may not always be available, and it may not be realistic to expect busy teachers to devise their own. Other limits of direct instruction have more to do with the very nature of learning. Some critics argue that organizing material on behalf of the students encourages students to be passive—an ironic and undesirable result if true (Kohn, 2000, 2006). According to this criticism, the mere fact that a curriculum or unit of study is constructed by a teacher (or other authority) makes some students think that they should not bother seeking information actively on their own, but wait for it to arrive of its own accord. In support of this argument, critics point to the fact that direct instruction approaches sometimes contradict their own premises by requiring students to do a bit of cognitive organizational work of their own. This happens, for example, when a mastery learning program provides enrichment material to faster students to work on independently; in that case the teacher may be involved in the enrichment activities only minimally.

Criticisms like these have led to additional instructional approaches that rely more fully on students to seek and organize their own learning. In the next section we discuss some of these options. As you will see, student-centered models of learning do solve certain problems of teacher-directed instruction, but they also have problems of their own.

Student-centered models of learning

Student-centered models of learning shift some of the responsibility for directing and organizing learning from the teacher to the student. Being student-centered does not mean, however, that a teacher gives up organizational and leadership responsibilities completely. It only means a relative shift in the teacher’s role, toward one with more emphasis on guiding students’ self-chosen directions. As we explained earlier in this chapter, teacher-directed strategies do not take over responsibility for students’ learning completely; no matter how much a teacher structures or directs learning, the students still have responsibility for working and expending effort to comprehend new material. By the same token, student-centered models of learning do not mean handing over all organizational work of instruction to students. The teacher is still the most knowledgeable member of the class, and still has both the opportunity and the responsibility to guide learning in directions that are productive.

As you might suspect, therefore, teacher-directed and student-centered approaches to instruction may overlap in practice. You can see the overlap clearly, for example, in two instructional strategies commonly thought of as student-centered, *independent study* and *self-reflection.* In **independent study**, as the name implies, a student works alone a good deal of the time, consulting with a teacher only occasionally. Independent study may be student-centered in the sense that the student may be learning a topic or skill—an exotic foreign language, for example—that is personally interesting. But the opposite may also be true: the student may be learning a topic or skill that a teacher or an official school curriculum has directed the student to learn—a basic subject for which the student is missing a credit, for example. Either way, though, the student will probably need guidance, support, and help from a teacher. In this sense even independent study always contain elements of teacher-direction.

Similarly, **self-reflection** refers to thinking about beliefs and experiences in order to clarify their personal meaning and importance. In school it can be practiced in a number of ways: for example by keeping diaries or logs of learning or reading, or by retelling stories of important experiences or incidents in a student’s life, or by creating concept maps like the ones described earlier in this chapter.

Whatever form it takes, self-reflection by definition happens inside a single student's mind, and in this sense is always directed by the student. Yet most research on self-reflection finds that self-reflection only works well when it involves and generates responses and interaction with other students or with a teacher (Seifert, 1999; Kuit, Reay, & Freeman, 2001). To be fully self-reflective, students need to have access to more than their existing base of knowledge and ideas—more than what they know already. In one study about students' self-reflections of cultural and racial prejudices (Gay & Kirkland, 2003), for example, the researchers found that students tended to reflect on these problems in relatively shallow ways if they worked on their own. It was not particularly effective to write about prejudice in a journal that no one read except themselves, or to describe beliefs in a class discussion in which neither the teacher nor classmates commented or challenged the beliefs. Much more effective in both cases was for the teacher to respond thoughtfully to students' reflective comments. In this sense the use of self-reflection, like independent study, required elements of teacher-direction to be successful.

How might a teacher emphasize students' responsibility for directing and organizing their own learning? The alternatives are numerous, as they are for teacher-directed strategies, so we can only sample some of them here. We concentrate on ones that are relatively well known and used most widely, and especially on two: inquiry learning and cooperative learning.

Inquiry learning

Inquiry learning stands the usual advice about expository (lecture-style) teaching on its head: instead of presenting well-organized knowledge to students, the teacher (or sometimes fellow students) pose thoughtful questions intended to stimulate discussion and investigation by students. The approach has been described, used, and discussed by educators literally for decades, though sometimes under other names, including *inquiry method* (Postman & Weingartner, 1969), *discovery learning* (Bruner, 1960/ 2006), or *progressive education* (Dewey, 1933; Martin, 2003). For convenience, we will stay with the term *inquiry learning.*

The questions that begin a cycle of inquiry learning may be posed either by the teacher or by students themselves. Their content depends not only on the general subject area being studied, but also on the interests which students themselves have expressed. In elementary-level science, for example, a question might be "Why do leaves fall off trees when winter comes?" In high school social studies classes, it might be "Why do nations get into conflict?" The teacher avoids answering such questions directly, even if asked to do so. Instead she encourages students to investigate the questions themselves, for example by elaborating on students' ideas and by asking further questions based on students' initial comments. Since students' comments can not be predicted precisely, the approach is by nature flexible. The initial questioning helps students to create and clarify questions which they consider worthy of further investigation. Discussing questions about leaves falling off trees, for example, can prompt students to observe trees in the autumn or to locate books and references that discuss or explain the biology of tress and leaves.

But inquiry is not limited to particular grade levels or topics. If initial questions in a high school social studies class have been about why nations get into conflict, for example, the resulting discussions can lead to investigating the history of past wars and the history of peace-keeping efforts around the world. Whether the topic is high school social studies or elementary school biology, the specific direction of investigations is influenced heavily by students, but with assistance from the teacher to insure that the students' initiatives are productive. When all goes well, the inquiry and resulting investigations benefit students in two ways. The first is that students (perhaps obviously) learn new knowledge from their investigations. The second is that students practice a constructive, motivating way of learning, one applicable to a variety of problems and tasks, both in school and out.

Cooperative learning

Even though inquiry-oriented discussion and investigation benefits when it involves the teacher, it can also be useful for students to work together somewhat independently, relying on a teacher's guidance only indirectly. Working with peers is a major feature of **cooperative learning** (sometimes also called *collaborative learning).* In this approach, students work on a task in groups and often are rewarded either partially or completely for the success of the group as a whole. Aspects of cooperative learning have been part of education for a long time; some form of cooperation has always been necessary to participate on school sports teams, for example, or to produce a student-run school newspaper. What is a bit newer is using cooperative or collaborative activities systematically to facilitate the learning of a range of educational goals central to the academic curriculum (Prince, 2004).

Even though teachers usually value cooperation in students, circumstances at school can sometimes reduce students' incentives to show it. The traditional practice of assessing students individually, for example, can set the stage for competition over grades, and cultural and other forms of diversity can sometimes inhibit individuals from helping each other spontaneously. Strategies exist, however, for reducing such barriers so that students truly benefit from each other's presence, and are more likely to feel like sharing their skills and knowledge. Here, for example, are several key features that make cooperative learning work well (Johnson & Johnson, 1998; Smith, et al., 2005):

- *Students need time and a place to talk and work together.* This may sound obvious, but it can be overlooked if time in class becomes crowded with other tasks and activities, or with interruptions related to school (like assemblies) but not to the classroom. It is never enough simply to tell students to work together, only to leave them wondering how or when they are to do so.
- *Students need skills at working together.* As an adult, you may feel relatively able to work with a variety of partners on a group task. The same assumption cannot be made, however, about younger individuals, whether teenagers or children. Some students may get along with a variety of partners, but others may not. Many will benefit from advice and coaching about how to focus on the tasks at hand, rather than on the personalities of their partners.
- *Assessment of activities should hold both the group and the individuals accountable for success.* If a final mark for a project goes only to the group as a whole, then freeloading is possible: some members may not do their share of the work and may be rewarded more than they deserve. Others may be rewarded less than they deserve. If, on the other hand, a final grade for a group project goes only to each member's individual contribution to a group project, then **overspecialization** can occur: individuals have no real incentive to work together, and cooperative may deteriorate into a set of smaller individual projects (Slavin, 1994).
- *Students need to believe in the value and necessity of cooperation.* Collaboration will not occur if students privately assume that their partners have little to contribute to their personal success. Social prejudices from the wider society—like racial bias or gender sexism, for example—can creep into the operations of cooperative groups, causing some members to be ignored unfairly while others are overvalued. Teachers can help reduce these problems in two ways: first by pointing out and explaining that a diversity of talents is necessary for success on a group project, and second by pointing out to the group how undervalued individuals are contributing to the overall project (Cohen, Brody, & Sapon-Shevin, 2004).

As these comments imply, cooperative learning does not happen automatically, and requires monitoring and support by the teacher. Some activities may not lend themselves to cooperative work, particularly if every member of the group is doing essentially the same task. Giving everyone in a group the same set of arithmetic problems to work on collaboratively, for example, is a formula for cooperative failure: either the most skilled students do the work for others (freeloading) or else members simply divide up the problems among themselves in order to reduce their overall work (overspecialization). A better choice for a cooperative task is one that clearly requires a diversity of skills, what some educators call a *rich group work task* (Cohen, Brody, & Sapon-Shevin, 2004). Preparing a presentation about medieval castles, for example, might require (a) writing skill to create a report, (b) dramatic skill to put on a skit and (c) artistic talent to create a poster. Although a few students may have all of these skills, more are likely to have only one, and they are therefore likely to need and want their fellow group members' participation.

Examples of cooperative and collaborative learning

Although this description may make the requirements for cooperative learning sound somewhat precise, there are actually a variety of ways to implement it in practice. Error: Reference source not found summarizes several of them. As you can see, the strategies vary in the number of how many students they involve, the prior organization or planning provided by the teacher, and the amount of class time they normally require.

Table 4 Strategies for encouraging cooperative learning

Strategy	Type of groups involved:	What the teacher does:	What the students do:
Think-pair-share (Lyman, 1981)	Pairs of students, sometimes linked to one other pair	Teacher poses initial problem or question.	First, students think individually of the answer; second, they share their thinking with partner; third, the partnership shares their thinking with another partnership.
Jigsaw classroom, version #1 (Aronson, et al., 2001)	5-6 students per group, and 5-6 groups overall	Teacher assigns students to groups and assigns one aspect of a complex problem to each group.	Students in each group work together to become experts in their particular aspect of the problem; later the expert groups disband, and form new groups containing one student from each of the former expert groups.
Jigsaw classroom, version #2 (Slavin, 1994)	4-5 students per group, and 4-5 groups overall	Teacher assigns students to groups and assigns each group to study or learn about the same *entire* complex problem.	Students initially work in groups to learn about the entire problem; later the groups disband and reform as expert groups, with each group focusing on a selected aspect of the general problem; still later the expert groups disband and the original general groups reform to learn what the expert students can now add to their general understanding.
STAD (Student-Teams-Achievement Divisions) (Slavin, 1994)	4-5 students per team (or group)	Teacher presents a lesson or unit to the entire class, and later tests them on it; grades individuals based partly on individuals' and the team's improvement, not just on absolute level of performance.	Students work together to insure that team mates improve their performance as much as possible. Students take tests as individuals.
Project-Based Learning (Katz, 2000)	Various numbers of students, depending on the complexity of the project, up to and including the entire class	Teacher or students pose a question or problem of interest to other students; teacher assists students to clarify their interests and to make plans to investigate the question further.	Students work together for extended periods to investigate the original question or problem; project leads eventually to a presentation, written report, or other product.

Instructional strategies: an abundance of choices

Looking broadly at this chapter, you can see that choices among instructional strategies are numerous indeed, and that deciding among them depends on the forms of thinking that you want to encourage, the extent to which ideas or skills need to be organized by you to be understood by students, and the extent to which students need to take responsibility for directing their own learning. Although you may have personal preferences among possible instructional strategies, the choice will also be guided by the uniqueness of each situation of teaching—with its particular students, grade-level, content, and purposes. If you need to develop students' problem solving skills, for example, there are strategies that are especially well suited for this purpose; we described some. If you need to organize complex information so that students do not become confused by it, there are effective ways of doing so. If you want the students to take as much initiative as possible in organizing their own learning, this too can be done.

Yet having this knowledge is still not enough to teach well. What is still needed are ideas or principles for deciding *what* to teach. In this chapter we have still not addressed an obvious question: How do I find or devise goals for my teaching and for my students' learning? And assuming that I can determine the goals, where can I find resources that help students to meet them?

Behavioral View of Learning

Several ideas and priorities, then, affect how we teachers think about learning, including the curriculum, the difference between teaching and learning, sequencing, readiness, and transfer. The ideas form a "screen" through which to understand and evaluate whatever psychology has to offer education. As it turns out, many theories, concepts, and ideas from educational psychology *do* make it through the "screen" of education, meaning that they are consistent with the professional priorities of teachers and helpful in solving important problems of classroom teaching. In the case of issues about classroom learning, for example, educational psychologists have developed a number of theories and concepts that are relevant to classrooms, in that they describe at least *some* of what usually happens there and offer guidance for assisting learning. It is helpful to group the theories according to whether they focus on changes in behavior or in thinking. The distinction is rough and inexact, but a good place to begin. For starters, therefore, consider two perspectives about learning, called behaviorism (learning as changes in overt behavior) and constructivism, (learning as changes in thinking). The second category can be further divided into psychological constructivism (changes in thinking resulting from individual experiences), and social constructivism, (changes in thinking due to assistance from others). The rest of this chapter describes key ideas from each of these viewpoints. As I hope you will see, each describes some aspects of learning not just in general, but as it happens in classrooms in particular. So each perspective suggests things that you might do in your classroom to make students' learning more productive.

Behaviorism: changes in what students do

Behaviorism is a perspective on learning that focuses on changes in individuals' observable behaviors—changes in what people say or do. At some point we all use this perspective, whether we call it "behaviorism" or something else. The first time that I drove a car, for example, I was concerned primarily with whether I could actually do the driving, not with whether I could describe or explain how to drive. For another example: when I reached the point in life where I began cooking meals for myself, I was more focused on whether I could actually produce edible food in a kitchen than with whether I could explain my recipes and cooking procedures to others. And still another example—one often relevant to new teachers: when I began my first year of teaching, I was more focused on doing the job of teaching—on day-to-day survival—than on pausing to reflect on what I was doing.

Note that in all of these examples, focusing attention on behavior instead of on "thoughts" may have been desirable at that moment, but not necessarily desirable indefinitely or all of the time. Even as a beginner, there are times when it *is* more important to be able to describe how to drive or to cook than to actually do these things. And there definitely are many times when reflecting on and thinking about teaching can improve teaching itself. (As a teacher-friend once said to me: "Don't just *do* something; *stand* there!") But neither is focusing on behavior which is not necessarily less desirable than focusing on students' "inner" changes, such as gains in their knowledge or their personal attitudes. If you are teaching, you will need to attend to all forms of learning in students, whether inner or outward.

In classrooms, behaviorism is most useful for identifying relationships between specific actions by a student and the immediate precursors and consequences of the actions. It is less useful for understanding changes in students' thinking; for this purpose we need a more *cognitive* (or thinking-oriented) theory, like the ones described later in this chapter. This fact is not really a criticism of behaviorism as a perspective, but just a clarification of its particular strength or source of usefulness, which is to highlight observable relationships among actions, precursors and consequences.

Behaviorists use particular terms (or "lingo", some might say) for these relationships. They also rely primarily on two basic images or models of behavioral learning, called *classical conditioning* and *operant conditioning*. The names are derived partly from the major learning mechanisms highlighted by each type, which I describe next.

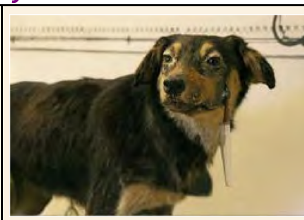
Classical conditioning: learning new associations with prior behaviors

As originally conceived, **classical conditioning** begins with the involuntary responses to particular sights, sounds, or other sensations (Lavond, 2003). When I receive an injection from a nurse or doctor, for example, I cringe, tighten my muscles, and even perspire a bit. Whenever a contented, happy baby looks at me, on the other hand, I invariably smile in response. I cannot help myself in either case; both of the responses are automatic. In humans as well as other animals, there is a repertoire or variety of such specific, involuntary behaviors. At the sound of a sudden loud noise, for example, most of us show a "startle" response—we drop what we are doing (sometimes literally!), our heart rate shoots up temporarily, and we look for the source of the sound. Cats, dogs and many other animals (even fish in an aquarium) show similar or equivalent responses.

Involuntary stimuli and responses were first studied systematically early in the twentieth-century by the Russian scientist Ivan Pavlov (1927). Pavlov's most well-known work did not involve humans, but dogs, and specifically their involuntary tendency to salivate when eating. He attached a small tube to the side of dogs' mouths that allowed him to measure how much the dogs salivated when fed (Table 1 shows a photograph of one of Pavlov's dogs). But he soon noticed a "problem" with the procedure: as the dogs gained experience with the experiment, they often salivated *before* they began eating. In fact the most experienced dogs sometimes began salivating before they even saw any food, simply when Pavlov himself entered the room! The sight of the experimenter, which had originally been a neutral experience for the dogs, became associated with the dogs' original salivation response. Eventually, in fact, the dogs would salivate at the sight of Pavlov even if he did *not* feed them.

This *change* in the dogs' involuntary response, and especially its growing independence from the food as stimulus, eventually became the focus of Pavlov's research. Psychologists named the process *classical conditioning* because it describes changes in *responses* to stimuli. Classical conditioning has several elements, each with a special name. To understand these, look at and imagine a dog (perhaps even mine, named Ginger) prior to any conditioning. At the beginning Ginger salivates (an **unconditioned response (UR)**) only when she actually tastes her dinner (an **unconditioned stimulus (US)**). As time goes by, however, a neutral stimulus—such as the sound of opening a bag containing fresh dog food—is continually paired with the eating/tasting experience. Eventually the neutral stimulus becomes able to elicit salivation even *before* any dog food is offered to Ginger, or even if the bag of food is empty! At this point the neutral stimulus is called a **conditioned stimulus (UCS)** and the original response is renamed as a **conditioned response (CR)**. Now, after conditioning, Ginger salivates merely at the sound of opening *any* large bag, regardless of its contents. (I might add that Ginger also engages in other conditioned responses, such as looking hopeful and following me around the house at dinner time.)

Table 1 Classical conditioning of Ginger, the dog. ***Before conditioning, Ginger salivates only to the taste of food and the bell has no effect. After conditioning, she salivates even when the bell is presented by itself.***

Before Conditioning: (UCS) **Food→ Salivation** (UR) (UCS) **Bell→ No response** (UR) During Conditioning: **Bell + Food→ Salivation** After Conditioning: (CS) **Bell only→ Salivation** (CR)	

Classical Conditioning and Students

"OK," you may be thinking, "Classical conditioning may happen to animals. But does anything like it happen in classrooms?" It might seem like not much would, since teaching is usually about influencing students' conscious words and thoughts, and not their involuntary behaviors. But remember that schooling is not just about encouraging thinking and talking. Teachers, like parents and the public, also seek positive changes in students' attitudes and feelings—attitudes like a love for learning, for example, and feelings like self-confidence. It turns out that classical conditioning describes these kinds of changes relatively well.

Consider, for example, a child who responds happily whenever meeting a new person who is warm and friendly, but who also responds cautiously or at least neutrally in any new situation. Suppose further that the "new, friendly person" in question is you, his teacher. Initially the child's response to you is like an unconditioned stimulus: you smile (the unconditioned stimulus) and in response he perks up, breathes easier, and smiles (the unconditioned response). This exchange is not the whole story, however, but merely the setting for an important bit of behavior change: suppose you smile at him while standing in your classroom, a "new situation" and therefore one to which he normally responds cautiously. Now classical-conditioning learning can occur. The initially neutral stimulus (your classroom) becomes associated repeatedly with the original unconditioned stimulus (your smile) and the child's unconditioned response (his smile). Eventually, if all goes well, the classroom becomes a conditioned stimulus in its own right: it can elicit the child's smiles and other "happy behaviors" even without your immediate presence or stimulus. Table 2 diagrams the situation graphically. When the change in behavior happens, you might say that the child has "learned" to like being in your classroom. Truly a pleasing outcome for both of you!

Table 2 Classical conditioning of student to classroom. ***Before conditioning, the student smiles only when he sees the teacher smile, and the sight of the classroom has no effect. After conditioning, the student smiles at the sight of the classroom even without the teacher present.***

Before Conditioning:
(UCS) **Seeing Teacher Smile → Student Smiles** (UR)
(UCS) **Seeing Classroom → No response** (UR)
During Conditioning:
Seeing Teaching Smile + Seeing Classroom → Student Smiles
After Conditioning:
(CS) **Seeing Classroom → Student Smiles** (CR)

But less positive or desirable examples of classical conditioning also can happen. Consider a modification of the example that I just gave. Suppose the child that I just mentioned did *not* have the good fortune of being placed in *your* classroom. Instead he found himself with a less likeable teacher, whom we could simply call Mr Horrible. Instead of smiling a lot and eliciting the child's unconditioned "happy response", Mr Horrible often frowns and scowls at the child. In this case, therefore, the child's initial *unconditioned* response is negative: whenever Mr Horrible directs a frown or scowl at the child, the child automatically cringes a little, his eyes widen in fear, and his heart beat races. If the child sees Mr Horrible doing most of his frowning and scowling *in* the classroom, eventually the classroom itself will acquire power as a negative conditioned stimulus. Eventually, that is, the child will not need Mr Horrible to be present in order to feel apprehensive; simply being in the classroom will be enough. Table 3 diagrams this unfortunate situation. Obviously it is an outcome to be avoided, and in fact does not usually happen in such an extreme way. But hopefully it makes the point: any stimulus that is initially neutral, but that gets associated with an unconditioned stimulus and response, can eventually acquire the ability to elicit the response by itself. *Anything*—whether it is desirable or not.

Table 3 Classical conditioning of student to classroom. ***Before conditioning, the student cringes only when he sees Mr Horrible smile, and the sight of the classroom has no effect. After conditioning, the student cringes at the sight of the classroom even without Mr Horrible present.***

Before Conditioning:
(UCS) **Mr Horrible Frowns → Student Cringes** (UCR)
Mr Horrible's Classroom → No response
During Conditioning:
Mr Horrible Frowns + Sight of Classroom → Student Cringes
After Conditioning:
(CS) **Seeing Classroom → Student Cringes** (CR)

The changes described in these two examples are important because they can affect students' attitude about school, and therefore also their *motivation* to learn. In the positive case, the child becomes more inclined to please the teacher and to attend to what he or she has to offer; in the negative case, the opposite occurs. Since the changes in attitude happen "inside" the child, they are best thought of as one way that a child can acquire *i* **intrinsic motivation**, meaning a desire or tendency to direct attention and energy in a particular way that originates from the child himself or herself. Intrinsic motivation is sometimes contrasted to **extrinsic motivation**, a tendency to direct attention and energy that originates from *outside* of the child. As we will see, classical conditioning can influence students' intrinsic motivation in directions that are either positive or negative. As you might suspect, there are other ways to influence motivation as well. Many of these will be described when we discuss the topic of student motivation later in the course. First, though, let us look at three other features of classical conditioning that complicate the picture a bit, but also render conditioning a bit more accurate, an appropriate description of students' learning.

Three key ideas about classical conditioning

Extinction: This term does not refer to the fate of dinosaurs, but to the *disappearance* of a link between the conditioned stimulus and the conditioned response. Imagine a third variation on the conditioning "story" described above. Suppose, as I suggested above, that the child begins by associating your happy behaviors—your smiles—to his being present in the classroom, so that the classroom itself becomes enough to elicit his own smiles. But now suppose there is a sad turn of events: you become sick and must therefore leave the classroom in the middle of the school year. A substitute is called in who is not Mr Horrible, but simply someone who is not very expressive, someone we can call Ms Neutral. At first the child continues to feel good (that is, to smile) whenever present in the classroom. But because the link between the classroom and your particular smile is no longer repeated or associated, the child's response gradually *extinguishes*, or fades until it has disappeared entirely. In a sense the child's initial learning is "unlearned".

Extinction can also happen with negative examples of classical conditioning. If Mr Horrible leaves mid-year (perhaps because no one could stand working with him any longer!), then the child's negative responses (cringing, eyes widening, heart beat racing, and so on) will also extinguish eventually. Note, though, that whether the conditioned stimulus is positive or negative, extinction does not happen suddenly or immediately, but unfolds over time. This fact can sometimes obscure the process if you are a busy teacher attending to many students.

Generalization: When Pavlov studied conditioning in dogs, he noticed that the original conditioned stimulus was not the only neutral stimulus that elicited the conditioned response. If he paired a particular bell with the sight of food, for example, so that the bell became a conditioned stimulus for salivation, then it turned out that *other* bells, perhaps with a different pitch or type or sound, also acquired some ability to trigger salivation—though not as much as the original bell. Psychologists call this process generalization, or the tendency for similar stimuli to elicit a conditioned response. The child being conditioned to your smile, for example, might learn to associate your smile not only with being present in *your* classroom, but also to being present in other, similar classrooms. His conditioned smiles may be strongest where he learned them initially (that is, in your own room), but nonetheless visible to a significant extent in other teachers' classrooms. To the extent that this happens, he has *generalized* his learning. It is of course good news; it means that we can say that the child is beginning to "learn to like school" in general, and not just your particular room. Unfortunately, the opposite can also happen: if a child learns negative associations from Mr Horrible, the child's fear, caution, and stress might generalize to other classrooms as well. The lesson for teachers is therefore clear: we have a responsibility, wherever possible, to make classrooms pleasant places to be.

Discrimination: Generalization among similar stimuli can be reduced if only one of the similar stimuli is associated consistently with the unconditioned response, while the others are not. When this happens, psychologists say that **discrimination learning** has occurred, meaning that the individual has learned to distinguish or respond differently to one stimulus than to another. From an educational point of view, discrimination learning can be either desirable or not, depending on the particulars of the situation. Imagine again (for the fourth time!) the child who learns to associate your classroom with your smiles, so that he eventually produces smiles of his own whenever present in your room. But now imagine yet another variation on his story: the child is old enough to attend *middle school*, and therefore has several teachers across the day. You—with your smiles—are one, but so are Mr Horrible and Ms Neutral. At first the child may generalize his classically conditioned smiles to the other teachers' classrooms. But the other teachers do not smile like you do, and this fact causes the child's smiling to extinguish somewhat in their rooms. Meanwhile, you keep smiling in your room. Eventually the child is smiling *only* in your room and not in the other rooms. When this happens, we say that **discrimination** has occurred, meaning that the conditioned associations happen only to a single version of the unconditioned stimuli—in this case, only to *your* smiles, and not to the (rather rare) occurrences of smiles in the other classrooms. Judging by his behavior, the child is making a distinction between your room and others.

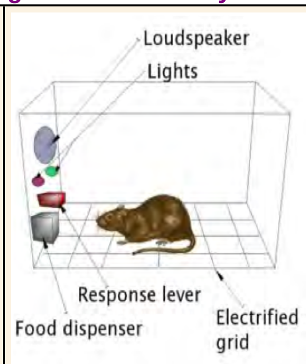
In one sense the discrimination in this story is unfortunate in that it prevents the child from acquiring a liking for school that is generalized. But notice that an opposing, more desirable process is happening at the same time: the child is also *prevented* from acquiring a generalized *dislike* of school. The fear-producing stimuli from Mr Horrible, in particular, become discriminated from the happiness-producing smiles from you, so the child's learns to confine his fearful responses to that particular classroom, and does not generalize them to other "innocent" classrooms, including your own. This is still not an ideal situation for the student, but maybe it is more desirable than disliking school altogether.

Operant conditioning: new behaviors because of new consequences

Instead of focusing on associations between stimuli and responses, **operant conditioning** focuses on how the effects of consequences on behaviors. The operant model of learning begins with the idea that certain consequences tend to make certain behaviors happen more frequently. If I compliment a student for a good comment during a discussion, there is more of a chance that I will hear comments from the student more often in the future (and hopefully they will also be good ones!). If a student tells a joke to several classmates and they laugh at it, then the student is more likely to tell additional jokes in the future and so on.

As with classical conditioning, the original research about this model of learning was not done with people, but with animals. One of the pioneers in the field was a Harvard professor named B. F. Skinner, who published numerous books and articles about the details of the process and who pointed out many parallels between operant conditioning in animals and operant conditioning in humans (1938, 1948, 1988). Skinner observed the behavior of rather tame laboratory rats (not the unpleasant kind that sometimes live in garbage dumps). He or his assistants would put them in a cage that contained little except a lever and a small tray just big enough to hold a small amount of food. (Table 4 shows the basic set-up, which is sometimes nicknamed a "Skinner box".) At first the rat would sniff and "putter around" the cage at random, but sooner or later it would happen upon the lever and eventually happen to press it. Presto! The lever released a small pellet of food, which the rat would promptly eat. Gradually the rat would spend more time near the lever and press the lever more frequently, getting food more frequently. Eventually it would spend *most* of its time at the lever and eating its fill of food. The rat had "discovered" that the consequence of pressing the level was to receive food. Skinner called the changes in the rat's behavior an example of **operant conditioning**, and gave special names to the different parts of the process. He called the food pellets the **reinforcement** and the lever-pressing the **operant** (because it "operated" on the rat's environment). See below.

Table 4 Operant conditioning with a laboratory rat

Operant → Reinforcement Press lever → Food pellet	

Skinner and other behavioral psychologists experimented with using various reinforcers and operants. They also experimented with various patterns of reinforcement (or **schedules of reinforcement**), as well as with various **cues** or signals to the animal about when reinforcement was available. It turned out that all of these factors—the operant, the reinforcement, the schedule, and the cues—affected how easily and thoroughly operant conditioning occurred. For example, reinforcement was more effective if it came immediately after the crucial operant behavior, rather than being delayed, and reinforcements that happened intermittently (only part of the time) caused learning to take longer, but also caused it to last longer.

Operant conditioning and students' learning: As with classical conditioning, it is important to ask whether operant conditioning also describes learning in human beings, and especially in students in classrooms. On this point the answer seems to be clearly "yes". There are countless classroom examples of consequences affecting students' behavior in ways that resemble operant conditioning, although the process certainly does not account for all forms of student learning (Alberto & Troutman, 2005). Consider the following examples. In most of them the operant behavior tends to become more frequent on repeated occasions:

- A seventh-grade boy makes a silly face (the operant) at the girl sitting next to him. Classmates sitting around them giggle in response (the reinforcement).
- A kindergarten child raises her hand in response to the teacher's question about a story (the operant). The teacher calls on her and she makes her comment (the reinforcement).
- Another kindergarten child blurts out her comment without being called on (the operant). The teacher frowns, ignores this behavior, but before the teacher calls on a different student, classmates are listening attentively (the reinforcement) to the student even though he did not raise his hand as he should have.
- A twelfth-grade student—a member of the track team—runs one mile during practice (the operant). He notes the time it takes him as well as his increase in speed since joining the team (the reinforcement).
- A child who is usually very restless sits for five minutes doing an assignment (the operant). The teaching assistant compliments him for working hard (the reinforcement).
- A sixth-grader takes home a book from the classroom library to read overnight (the operant). When she returns the book the next morning, her teacher puts a gold star by her name on a chart posted in the room (the reinforcement).

Hopefully these examples are enough to make four points about operant conditioning. First, the process is widespread in classrooms—probably more widespread than classical conditioning. This fact makes sense, given the nature of public education: to a large extent, teaching is about making certain consequences for students (like praise or marks) depend on students' engaging in certain activities (like reading certain material or doing assignments). Second, learning by operant conditioning is not confined to any particular grade, subject area, or style of teaching, but by nature happens in nearly every imaginable classroom. Third, teachers are not the only persons controlling reinforcements. Sometimes they are controlled by the activity itself (as in the track team example), or by classmates (as in the "giggling" example). A result of all of the above points is the fourth: that multiple examples of operant conditioning often happen at the same time. The skill builder for this chapter (*The decline and fall of Jane Gladstone*) suggests how this happened to someone completing student teaching.

Because operant conditioning happens so widely, its effects on motivation are a bit more complex than the effects of classical conditioning. As in classical conditioning, operant conditioning can encourage **intrinsic motivation** to the extent that the reinforcement for an activity can sometimes be the activity itself. When a student reads a book for the sheer enjoyment of reading, for example, he is reinforced by the reading itself; then we often say that his reading is "intrinsically motivated". More often, however, operant conditioning stimulates *both* intrinsic *and* extrinsic motivation at the same time. The combining of both is noticeable in the examples that I listed above. In each example, it is reasonable to assume that the student felt intrinsically motivated to some partial extent, even when reward came from outside the student as well. This was because *part* of what reinforced their behavior was the behavior itself—whether it was making faces, running a mile, or contributing to a discussion. At the same time, though, note that each student probably was also **extrinsically motivated**, meaning that another part of the reinforcement came from consequences or experiences *not* inherently part of the activity or behavior itself. The boy who made a face was reinforced not only by the pleasure of making a face, for example, but *also* by the giggles of classmates. The track student was reinforced not only by the pleasure of running itself, but *also* by knowledge of his improved times and speeds. Even the usually restless child sitting still for five minutes may have been reinforced partly by this brief experience of unusually focused activity, even if he was *also* reinforced by the teacher aide's compliment. Note that the extrinsic part of the reinforcement may sometimes be more easily observed or noticed than the intrinsic part, which by definition may sometimes only be experienced within the individual and not also displayed outwardly. This latter fact may contribute to an impression that sometimes occurs, that operant conditioning is really just "bribery in disguise", that only the *external* reinforcements operate on students' behavior. It is true that external reinforcement may sometimes alter the nature or strength of internal (or intrinsic) reinforcement, but this is not the same as saying that it destroys or replaces intrinsic reinforcement. But more about this issue later!

Comparing operant conditioning and classical conditioning: Operant conditioning is made more complicated, but also more realistic, by many of the same concepts as used in classical conditioning. In most cases, however, the additional concepts have slightly different meanings in each model of learning. Since this circumstance can make the terms confusing, let me explain the differences for three major concepts used in both models—extinction, generalization, and discrimination. Then I will comment on two additional concepts—schedules of reinforcement and cues—that are sometimes also used in talking about both forms of conditioning, but that are important primarily for understanding operant conditioning.

Table 5 Comparison of terms common to operant and classical conditioning

Term	As defined in classical conditioning	As defined in operant conditioning
Extinction	Disappearance of an association between a conditioned stimulus and a conditioned response	Disappearance of the operant behavior due to lack of reinforcement
Generalization	Ability of stimulus similar to the conditioned stimulus to elicit the conditioned response	Tendency of behaviors similar to operant to be conditioned along with the original operant
Discrimination	Learning **not** to respond to stimuli that are similar to the originally conditioned stimulus	Learning **not** to emit behaviors that are similar to the originally conditioned operant
Schedule of Reinforcement	The pattern or frequency by which a CS is paired with the UCS during learning	The pattern or frequency by which a reinforcement is a consequence of an operant during learning
Cue	Not applicable	Stimulus prior to the operant that signals the availability or not of reinforcement

In both classical and operant conditioning, **extinction** refers to the disappearance of "something". In operant conditioning, what disappears is the *operant behavior* because of a lack of reinforcement. A student who stops receiving gold stars or compliments for prolific reading of library books, for example, may extinguish (i.e. decrease or stop) book-reading behavior. In classical conditioning, on the other hand, what disappears is association between the conditioned stimulus (the CS) and the conditioned response (CR). If you stop smiling at a student, then the student may extinguish her association between you and her pleasurable response to your smile, or between your classroom and the student's pleasurable response to your smile.

In both forms of conditioning, **generalization** means that something "extra" gets conditioned if it is somehow similar to "something". In operant conditioning, the extra conditioning is to behaviors similar to the original *operant*. If getting gold stars results in my reading more library books, then I may generalize this behavior to other similar activities, such as reading the newspaper, even if the activity is not reinforced directly. In classical conditioning, however, the extra conditioning refers to *stimuli* similar to the original conditioned stimulus. If I am a student and I respond happily to my teacher's smiles, then I may find myself responding happily to other people (like my other teachers) to some extent, even if they do not smile at me. Generalization is a lot like the concept of *transfer* that I discussed early in this chapter, in that it is about extending prior learning to new situations or contexts. From the perspective of operant conditioning, though, what is being extended (or "transferred" or generalized) is a behavior, not knowledge or skill.

In both forms of conditioning, **discrimination** means learning **not** to generalize. In operant conditioning, though, what is **not** being overgeneralized is the operant behavior. If I am a student who is being complimented (reinforced) for contributing to discussions, I must also learn to discriminate when to make verbal contributions from when **not** to make verbal contributions—such as when classmates or the teacher are busy with other tasks. In classical conditioning, what are **not** being overgeneralized are the conditioned stimuli that elicit the conditioned response. If I, as a student, learn to associate the mere sight of a smiling teacher with my own happy, contented behavior, then I also have to learn *not* to associate this same happy response with similar, but slightly different sights, such as a teacher looking annoyed.

In both forms of conditioning, the **schedule of reinforcement** refers to the pattern or frequency by which "something" is paired with "something else". In operant conditioning, what is being paired is the pattern by which reinforcement is linked with the operant. If a teacher praises me for my work, does she do it every time, or only sometimes? Frequently or only once in awhile? In classical conditioning, however, the schedule in question is the pattern by which the conditioned stimulus is paired with the unconditioned stimulus. If I am student with Mr Horrible as my teacher, does he scowl every time he is in the classroom, or only sometimes? Frequently or rarely?

Behavioral psychologists have studied schedules of reinforcement extensively (for example, Ferster, et al., 1997; Mazur, 2005), and found a number of interesting effects of different schedules. For teachers, however, the most important finding may be this: partial or intermittent schedules of reinforcement generally cause learning to take longer, but also cause extinction of learning to take longer. This dual principle is important for teachers because so much of the reinforcement we give is partial or intermittent. Typically, if I am teaching, I can compliment a student a lot of the time, for example, but there will inevitably be occasions when I cannot do so because I am busy elsewhere in the classroom. For teachers concerned both about motivating students and about minimizing inappropriate behaviors, this is both good news and bad. The good news is that the benefits of my praising students' constructive behavior will be more lasting, because they will not extinguish their constructive behaviors immediately if I fail to support them every single time they happen. The bad news is that students' negative behaviors may take longer to extinguish as well, because those too may have developed through partial reinforcement. A student who clowns around inappropriately in class, for example, may not be "supported" by classmates' laughter every time it happens, but only some of the time. Once the inappropriate behavior is learned, though, it will take somewhat longer to disappear even if everyone—both teacher and classmates—make a concerted effort to ignore (or extinguish) it.

Finally, behavioral psychologists have studied the effects of **cues**. In operant conditioning, a cue is a stimulus that happens just prior to the operant behavior and that signals that performing the behavior may lead to reinforcement. Its effect is much like discrimination learning in classical conditioning, except that what is "discriminated" in this case is not a conditioned behavior that is reflex-like, but a voluntary action, the operant. In the original conditioning experiments, Skinner's rats were sometimes cued by the presence or absence of a small electric light in their cage. Reinforcement was associated with pressing a lever when, and only when, the light was on. In classrooms, cues are sometimes provided by the teacher or simply by the established routines of the class. Calling on a student to speak, for example, can be a cue that *if* the student *does* say something at that moment, then he or she *may* be reinforced with praise or acknowledgment. But if that cue does *not* occur—if the student is *not* called on—speaking may *not* be rewarded. In more everyday, non-behaviorist terms, the cue allows the student to learn when it is acceptable to speak, and when it is not.

1 Cognitive View

1.1 Cognitive View: Information-Processing Theory (Part 1)

Information-processing theory is a psychological theory about how we process and learn information. Clearly, this is a topic that is at the core of the everyday work of a classroom teacher, so let's spend some time exploring this theory and how it applies in the classroom.

Human Cognitive Architecture

The phrase *human cognitive architecture* is just a fancy academic way of referring to the areas of the human brain involved in thinking. Don't be dazzled by this term—it means little more than what I've just told you.

But now we're going to explore the details of human cognitive architecture and show why this is such an important topic for classroom teachers to understand.

Thinking Wasn't Always Fashionable

Before we discuss cognitive architecture we should first say that it used to be the case that few scholars wished to speculate about how the mind thinks. Researchers known as “behaviorists” preferred to talk only about *observable* aspects of learning—in other words, what was put into the system (e.g., teachers' questions) and what came out of it (e.g., students' responses). In fact, there was fierce resistance among these folks to use terms such as “think” because there could be no direct observation of thinking; therefore, any claim about thinking must necessarily be restricted to conjecture and was thus off-limits. A few of these folks are still around today, but most of them have been converted to a new way of—*dare I say it?*—thinking.

Information Processing

Long ago and far away, in the late 1960s and throughout the 1970s, researchers became increasingly dissatisfied with the behaviorist explanations of learning and began to work on some new models explaining how people learn. Most famously, Richard Atkinson and Richard Shiffrin (1968) proposed a cognitive model describing how the mind processes information. This model remains popular even today, so we will take a close look at it now.

Although somewhat oversimplified when compared to more recent work in this field, Atkinson and Shiffrin's model has become known simply as “the information-processing model.” The basic notion of this model is that it tracks the flow of information as new knowledge moves from the entry point toward permanent storage within the information-processing system. The model proposes three storage compartments (see Figure 1.1), known as “stores,” which hold information at various points during processing.

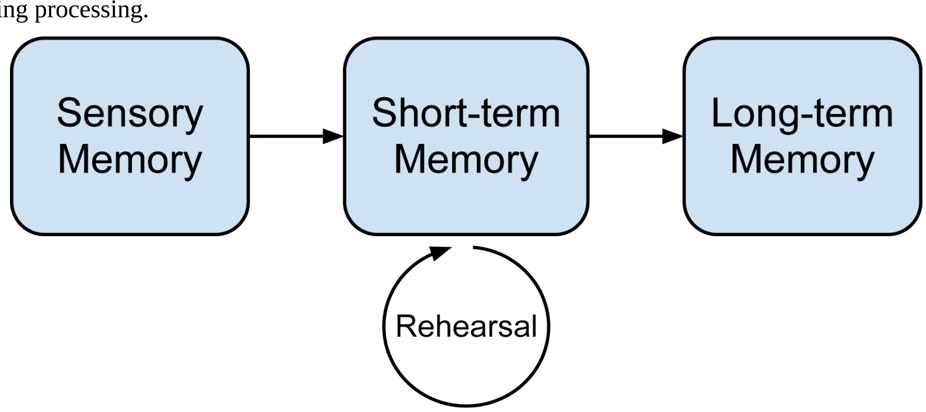


Figure 1.1 Atkinson and Shiffrin's (1968) information-processing model. Note that short-term memory is now more commonly known as “working memory.”

Sensory Memory

The first store is known as *sensory memory*. This is the entry point for all information coming into the system. Specifically, the kinds of information that sensory memory processes are signals from the five senses: sight, hearing, taste, smell, and touch. Because these senses are always up and running, they are continuously delivering new data to the sensory memory (even during sleep). Take a moment to close your eyes and notice the information from your other four senses that you were unaware of when you began reading this paragraph (e.g., whether your chair is cushioned or hard, whether your neck feels warm or cool, etc.).

Capacity and Duration

Although sensory memory can hold quite a lot of information, it cannot keep any of this information for very long due to the constant inflow of new data. Estimates of duration vary somewhat, but most agree that information cannot be kept active in sensory memory for more than a few (e.g., 3-5) seconds.

We cannot possibly process all of the data that sensory memory intakes. Therefore, we must select those sensory data that are relevant to whatever task we are currently undertaking—and ignore the rest. For the most part, we do this without being very aware of it.

One bothersome aspect of sensory memory is that it collects some sensory data that we wish we could ignore. Have you ever tried to concentrate, perhaps on school assignments, but felt distracted by the goings-on around you? That is a classic example of having sensory data that you felt compelled to process when it didn't meaningfully benefit you.

> Imagine Pierre, a student in a busy classroom where a teacher is giving a group of students directions for an assignment. Pierre is trying to concentrate on the teacher's instructions, but some other students are creating a distraction with a butterfly display on the other side of the room. The problem here, from a cognitive perspective, is that Pierre cannot effectively process both the actions of his classmates and the teacher's directions; he must choose whether to pay attention to the distraction or to his teacher. All of this information is contained in sensory memory, but not all of it can be processed in working memory, for reasons we discuss next.

Example 1.1 Application Activity

How many times have you seen a penny? Would you be able to recognize a penny if you saw one? Go to http://go.edpsych.net/cents (http://go.edpsych.net/cents) and see if you can indentify which one is the real penny. Explain, based on the information-processing model, why you (or someone else) might have difficulty with this task.

Working Memory

Let's clear something up before we get ourselves too involved talking about working memory. Atkinson and Shiffrin originally called this store "short-term memory" (to contrast with long-term memory), but modern researchers use the term "working memory" instead. These two terms have some rather subtle distinctions (which cognitive scholars care deeply about), but for our purposes the differences are negligible. Thus, in this discussion, we will prefer the more common term "working memory."

Working memory is where the real business of thinking takes place. This is where your students will process the content of your carefully crafted lessons as well as your instructions for how to complete their assignments—oh yes, and your warnings regarding proper decorum in the classroom. This is where rocket scientists do their thing, eventually accomplishing moon landings, sending spacecraft to land with precision on other planets millions of miles away, and the like. Now you can see that working memory is a space to be respected (please remove your hat, if you are wearing one).

Capacity

The pity is, in spite of all of its capabilities, working memory is a very small place. Well before Atkinson and Shiffrin developed their information-processing model, George Miller (1956) discovered that most individuals have approximately seven cognitive "slots" available to be filled with information at any given time and that this number varies by about two slots across the population, yielding the now-popular estimate of “seven plus or minus two” elements available in working memory to hold all the information one wishes to cram in.

> Take a moment now to think how you might remember a telephone number if you had to look it up and then walk over to a phone a short distance away to dial that number. If it is a local number, it has seven digits. As long as your working memory has seven slots available, you should be good to go. But what if someone delivers some surprising news to you halfway through your walk to the phone? It is unlikely that you will remember the phone number because you will be using some of your working-memory capacity to process the news you have just received. The point is, working memory is just too small for us to do everything we would like to be capable of doing.

This limited capacity has profound implications for teaching and learning. Let us now consider how the students in your classroom are affected. If you provide them with complicated instructions for an assignment, there is likely minimal space remaining in working memory for them to comprehend the content. Likewise, if the pace of your instruction is too fast, with lots of information conveyed at a quick pace, there will be little chance for your students to sufficiently process the information, and maybe even not enough opportunity for them to write it down for later study. A disciplined, controlled pace of presentation is essential if meaningful learning is to occur.

Example 1.2 Demonstration Activity

You might be surprised how quickly information escapes from your working memory. Go to http://go.edpsych.net/wm (http://go.edpsych.net/wm) and see how well you score!

Maintenance and Elaborative Rehearsal

You might be wondering exactly what happens while information is being processed in working memory. What does it mean for information to be “processed”? We typically refer to processing in working memory with the term *rehearsal.* There are two principal types of rehearsal: maintenance and elaborative. *Maintenance rehearsal* is what you were likely doing as you walked from the telephone book to the nearest phone across the room—i.e., repeating the information over and over to yourself in order to keep it “active.” This is by far the easiest type of rehearsal but it is also the least effective. How well will you remember that phone number two hours from now?

The second type of rehearsal is *elaborative rehearsal.* When one uses elaborative rehearsal, one connects the new information with previously learned information; this integration of old and new information has a dramatic impact on the memorability of the new information. Let's go back to that phone number. Imagine that you recognize the last four digits to be the same as the house number where you lived for your entire childhood. Now is the phone number easier to remember? Of course it is. The integration of prior knowledge (the house number) with new information (the phone number) improves the memorability of the phone number.

Duration

How long does information hang around in working memory? If it is being rehearsed, information will be active until rehearsal of that information ceases. But if no particular processing strategy (e.g., maintenance or elaborative rehearsal) is being applied to the information, it will vanish from working memory within 5-20 seconds. The reason for that broad estimate is that the information could die a slower death if no new information is imported into working memory to consume whatever limited space is available. Neglected information will not survive long in a busy working memory.

> As a teacher, it is tempting to conclude that your students will understand and remember simple information (like a brief fact or quick directions) that you have just told them. However, consider the situation in which a student, Karla, is still trying to understand a previously explained concept. Karla's working memory is operating at full capacity with attempts to process earlier information and thus cannot successfully deal with the simple instruction or fact that you have now stated. Working memory is altogether too limited to thoroughly process rapidly delivered information.

Attention

The concept of *attention* is one's focus on a given portion of all possible stimuli. This is also the layman's understanding of the term “attention,” so you are already familiar with this idea. Whatever you are thinking about (i.e., whatever is currently in working memory) is what you are paying *attention* to. We sometimes use the phrase “selective attention” to indicate that we must select a limited amount of information to process, and ignore the remainder of the incoming information streams.

Example 1.3 Demonstration Activity

Notice how selective attention is necessary to focus on the target voice and number in this activity: http://go.edpsych.net/selattn (http://go.edpsych.net/selattn)

Practice and Automaticity

The longer a piece of information is effectively processed (e.g., through elaborative rehearsal), the more we understand it and the more likely we will be to remember it at a later time. In layman's terms, this is called *practice.* In the classroom, first-graders will need to practice their reading skills more than sixth-graders because the sixth-graders have “put in their time” already and have spent a considerable number of hours practicing their reading to the point where it is now automatic. When a skill (such as reading) has been *automatized,* it requires fewer working-memory resources and thus consumes less space in working memory; this has the benefit of freeing up the remaining space in working memory for other thoughts. For example, how burdensome is it for you to figure out how to pronounce the word “conundrum” compared to the time it would take a first-grader? Because you can easily process this word, you can simultaneously consider the ideas “conundrum” and “Aunt Mary's wallet is missing from her purse, and we didn't see anyone enter or exit the room.” A first-grader would be capable of comparing these ideas but would require much more time to arrive at a complete understanding of the intersection between these two ideas than you would need, because you have already automatized much of the requisite processing.

In summary, then, practice speeds up processing because it automatizes critical skills.

Long-Term Memory

Long-term memory is just what it sounds like: an area that stores information permanently. To arrive in long-term memory, information must have been sufficiently processed in working memory. Stated another way, working memory is the exclusive route to long-term memory. How does information become “sufficiently processed” in working memory? By considering both the amount of time spent and the quality of processing encountered there. We will discuss different qualities of information processing later. For now, keep in mind that the amount of time one spends thinking about a topic (e.g., preparing for an exam) does not necessarily predict one's memory for that material at a future point in time.

Duration and Capacity

As far as we know, information is maintained in long-term memory indefinitely; there are no known expiration dates here. Additionally, there is no known limit to the amount of knowledge that can be stored in long-term memory. No one can credibly make the excuse that they don't have room to store any more information!

Now perhaps you can begin to see why it is important for teachers to understand human cognitive architecture. Without fully appreciating the capabilities and limitations of the information-processing system, teachers could easily have unrealistic expectations for their students—and that is not good for anybody.

References

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1.2 Cognitive View: Information-Processing Theory (Part 2)

Principles of Effective Learning

We now turn to a few empirical principles, derived from decades of research, that are known to improve learning. These principles will not all apply to every learning situation; however, each of them has been sufficiently demonstrated through carefully controlled scientific studies to merit mentioning them here.

The overarching goal here is to select processing strategies that will increase the likelihood of a learner recalling new information at a later point in time.

Activate Prior Knowledge

One of the most important cognitive principles for a teacher to keep in mind is the importance of relating information from long-term memory to information newly entering the system. Recall our discussion of elaborative rehearsal earlier, in which I indicated that making a connection to prior knowledge is a superior learning method to simply repeating information over and over without altering it.

Any good lesson-plan format begins the class with some form of prior-knowledge activation. It might be a reminder or a brief review of what was studied in the previous day's lesson, or it could be a question similar to, “Have you ever had a problem you couldn't solve?” The purpose of this phase of the lesson is to activate prior knowledge–i.e., bring long-term memories back into working memory–so that new knowledge can be mingled with old with the result of more solid understanding of the new (and perhaps even the old) information.

Example 1.4 Demonstration Activity

Remember that *having* prior knowledge is not good enough; that knowledge needs to be *activated* in order to make use of it. Go to http://go.edpsych.net/implicit (http://go.edpsych.net/implicit) and notice that you will identify previously seen words more quickly than “new” words (which you have prior knowledge of, but have not recently been activated).

Organization

This is one principle that applies to a rather restricted set of instructional situations, but it is so powerful that it deserves mention here. In contexts where there is a list of items to commit to memory, the task of memorizing the list will be much easier if the items are grouped together (i.e., organized) in a meaningful way. This also works as a basic memory strategy in everyday life—think about your latest visit to the grocery store and imagine remembering a rather random assortment of items versus grouping the dairy items together, the produce items together, etc.

Deep Processing

It is easy to become convinced that if a student spends, say, twenty hours reviewing for an exam, that student should be expected to excel on the exam. However, cognitive studies show that it is not specifically the *time* one spends studying that matters most; what one *does* during that time matters even more.

Consider, for example, the all-too-common exam-preparation strategy of using flash cards. Students often take terms from the textbook or class discussions, write them down on flash cards, and then rehearse what is written down until the flash cards are memorized. Such a student will walk into the exam confident that the material has been thoroughly mastered. The problem with this approach to studying is that the student has only done “surface-level processing” of the material, rather than “deep” processing. It is surface-level because the student has memorized terms and definitions rather than truly understanding the meaning and applications of those concepts.

Deep processing happens when one uses *elaborative rehearsal* to connect a concept to other concepts that are already known or are being learned. For example, one could write a summary of a concept in one's own words to check for comprehension. Another approach to facilitate deep processing is to think of examples of the newly learned concept from one's own life. One could even make up fictitious examples of the concept if no examples come to mind from one's past experience.

The point is, learning that comes from surface-level processing is not durable. One does not remember the content of flash cards for very long after the exam. But spending the same amount of time (or even less time) meaningfully engaged with the to-be-learned ideas can result in learning that could last for a lifetime.

Distributed Practice

There is one final principle for effective learning that must be mentioned here. To be the most effective learner, one should “space” or “distribute” one's studying over a period of time. Attempting to cram a lot of learning into one or two concentrated study sessions rarely works. Research cannot prescribe the specific number or length of study sessions required to maximize learning—there are too many variables to account for (e.g., one's prior knowledge of the topic, one's knowledge of related topics, the quality of one's study strategies, etc.). But the benefits of distributing one's study sessions over a period of time are well documented in the research literature.

References

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1.3 Cognitive View: Parallel Distributed Processing

Organizing new information

There are many ways to organize new information that are especially well-suited to teacher-directed instruction. A common way is simply to ask students to **outline information** read in a text or heard in a lecture. Outlining works especially well when the information is already organized somewhat hierarchically into a series of main topics, each with supporting subtopics or subpoints. Outlining is basically a form of the more general strategy of **taking notes**, or writing down key ideas and terms from a reading or lecture. Research studies find that that the precise style or content of notes is less important that the quantity of notes taken: more detail is usually better than less (Ward & Tatsukawa, 2003). Written notes insure that a student thinks about the material not only while writing it down, but also when reading the notes later. These benefits are especially helpful when students are relatively inexperienced at school learning in general (as in the earlier grade levels), or relatively inexperienced about a specific topic or content in particular. Not surprisingly, such students may also need more guidance than usual about *what* and *how* to write notes. It can be helpful for the teacher to provide a note-taking guide, like the ones shown in Exhibit 1.

Example 1.5

Example 1.6 Notes on Science Experiment

1. Purpose of the experiment (in one sentence):
2. Equipment needed (list each item and define any special terms):
4. Procedure used (be specific!):
5. Results (include each measurement, rounded to the nearest integer):

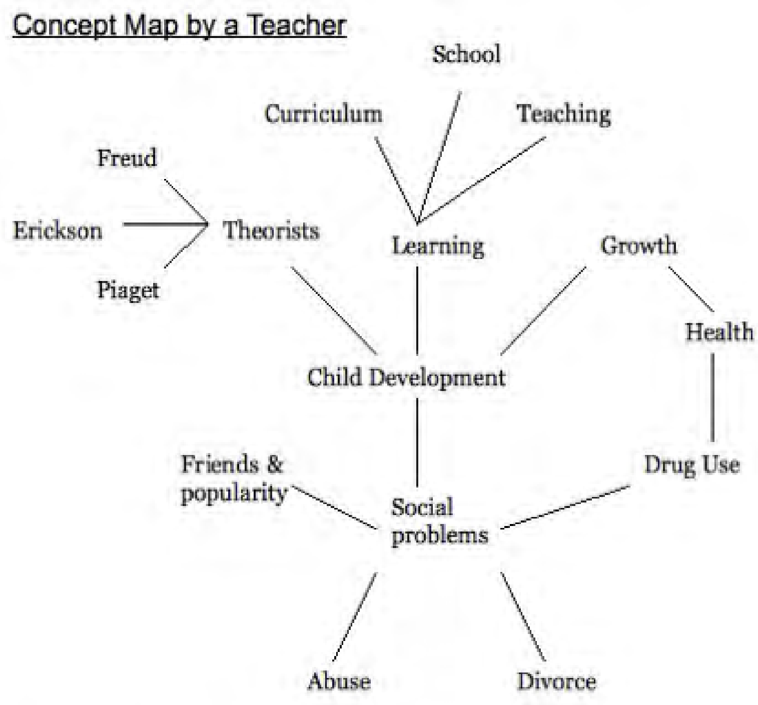
Table 1.1

Observation #1	
Observation #2	
Observation #3	
Observation #4	
Average measurement, #1-4:	

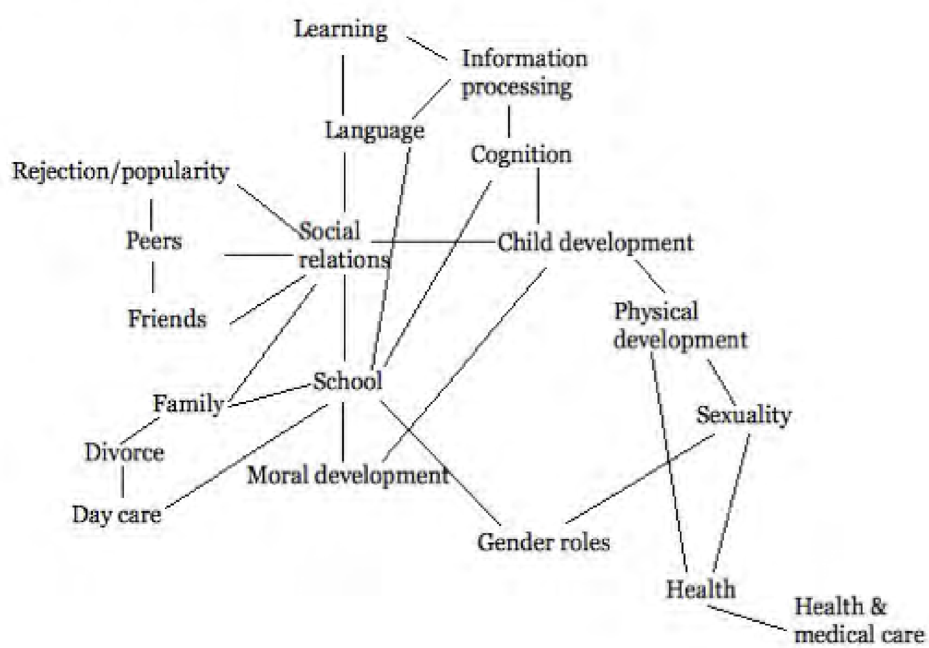
Example 1.7 Guide to Notes About *Tale of Two Cities:*

1. Main characters (list and describe in just a few words):
2. Setting of the story (time and place):
3. Unfamiliar vocabulary in the story (list and define):
4. Plot (write down only the main events):
5. Theme (or underlying "message") of the story:

In learning expository material, another helpful strategy—one that is more visually oriented—is to make **concept maps**, or diagrams of the connections among concepts or ideas. Exhibit 5 shows concept maps made by two individuals that graphically depict how a key idea, *child development*, relates to learning and education. One of the maps was drawn by a classroom teacher and the other by a university professor of psychology (Seifert, 1991). They suggest possible differences in how the two individuals think about children and their development. Not surprisingly, the teacher gave more prominence to practical concerns (for example, classroom learning and child abuse), and the professor gave more prominence to theoretical ones (for example, Erik Erikson and Piaget). The differences suggest that these two people may have something different in mind when they use the same term, *child development.* The differences have the potential to create misunderstandings between them (Seifert, 1999; Super & Harkness, 2003). By the same token, the two maps also suggest what each person might need to learn in order to achieve better understanding of the other person's thinking and ideas.



(a)



(b)

Figure 1.2 Maps of personal definitions of “child development”

Parallel Distributed Processing

Concept maps have their origin in the **Parallel Distributed Processing (PDP)** model, also called the **Connectionist Model**, of memory (McClelland & Rumelhart, 1981). The PDP model is based on the premise that our memory system consists of an interconnected series of **nodes**, or concepts. Our understanding of an individual concept depends on the connections made between that node and other nodes. For instance, child development is a node in the concept maps above. Each individual's understanding of child development depends on the nodes that are connected to the child development node. If the child development node was not connected to other nodes, the individual would not know anything about child development.

According to the PDP model, our memory system functions through the activation of nodes. When a node is activated, turned on, it becomes accessible to your conscious thought. A node can be activated by an external stimulus, such as a test question on child development, or by another node. When a node is turned on it activates the nodes connected to it. The node causing the activation is called a **prime** and its activation of other nodes is called the **priming effect**. The activation of nodes acts in a cascading way, with each activated node activating the nodes connected to it. For instance, in concept map "a" above the activation of child development would result in the activation of theorists, learning, growth, and social problems. Each of these nodes would activate the nodes connected to them. For instance, theorists would activate Freud, Erickson, and Piaget. This cascading series of activations is called **spreading activation**. The *parallel* part of the Parallel Distributed Processing model represents the fact that all this activation occurs at the same time (i.e., in parallel).

In the classroom, the PDP model is used when teachers introduce new topics by asking students to recall related information that they already know. For instance, a teacher might start a lecture on Piaget by asking students to recall the definition of child development. Recalling the definition of child development will activate a student's nodes related to child development, allowing them to make connections between Piaget and other concepts they know related to child development.

Reference

McClelland, J. L. & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review, 88*, 375-407.

1.4 Cognitive View: Cognitive Load Theory

Cognitive Load Theory

The information-processing model has given rise to a theory of instructional design called *cognitive load theory* (Sweller & Chandler, 1994; van Merriënboer & Sweller, 2005). Because working memory is the principal player in the process of learning new information, cognitive load theory focuses exclusively on working memory. The gist of this theory is that there are distinct types of demands imposed upon working memory during learning: intrinsic, extraneous, and germane. We now examine each of these.

Intrinsic Cognitive Load

Intrinsic cognitive load represents the burden imposed on working memory by the inherent nature of the material. In other words, simple topics require very little processing capacity in working memory, and complex topics demand a large amount of space. For example, it requires considerably more focus to safely drive a semi truck through a rainstorm than to sign your name with a pen on paper. Driving the semi requires attention to many different information inputs (e.g., gauges, mirrors, windshield) and coordinating the requisite motor skills in response; all of this processing is conducted in working memory. Signing one's name takes barely any attention at all (for adults) because it has been done thousands of times before. Thus, the effect of having practiced the skill reduces its intrinsic cognitive load.

But practice alone cannot reduce the intrinsic cognitive load of all tasks. The *element interactivity* (i.e., coordination among multiple aspects) inherent in some tasks cannot ultimately reduce the task to a trivial activity, even with extensive practice. If that were the case, we should all be capable of becoming skilled airline pilots or successful politicians.

For beginners learning an essential skill, element interactivity becomes problematic and must be temporarily reduced. When learning a language, one first learns the alphabet and then proceeds to acquire simple words or phrases—not complex prose. But one cannot be considered proficient in a language unless one can understand its complex prose. This is an example of element interactivity because understanding prose depends upon not only understanding its nouns, verbs, adverbs, etc., but also how each of them modifies or alters the meaning of other words nearby. Topics or skills that contain element interactivity must at first be oversimplified and then gradually built up to their full complexity before one can successfully deal with the intrinsic cognitive load.

Extraneous Cognitive Load

Extraneous cognitive load is the set of mental demands that are irrelevant to the current task. Recall the butterfly display that was distracting Pierre (mXXXXX (http://cnx.org/content/mXXXXX/latest/#uid3))? The butterflies had nothing to do with the directions the teacher was giving Pierre's group, yet Pierre was distracted by his classmates on the other side of the room. His classmates' activity was extraneous cognitive load for Pierre because it was consuming his precious cognitive resources yet not providing any real benefit to him in the task of understanding his teacher's directions.

It is critical to realize that these various forms of cognitive load are *additive*—that is, they each increase the amount of processing space that is active in working memory. For example, if the intrinsic load is already high, there is not much room for any extraneous load unless the learner decides (like Pierre) to reduce the processing of the intrinsic load and focus more on the extraneous load. Teachers should strive to reduce extraneous cognitive load in their classrooms because students are likely to sacrifice attention to important material and distract themselves with the extraneous stimuli.

Extraneous cognitive load is, for the most part, under the direct control of the teacher. Have you ever seen presentations that were decorated with graphics which were only tangentially related to the content? You probably found yourself sidelined by the images and not paying sufficient attention to the material itself. Because working memory has such a limited capacity, we cannot afford to “clutter up” this valuable space with unproductive ideas that divert attention from more important content. As a teacher, you should make earnest efforts to avoid exposing students to extra “fluff” during learning activities.

Germane Cognitive Load

Germane cognitive load has been explained in various ways. The explanation I prefer is the more traditional characterization that germane load represents increased demand upon working memory in the service of the learning goal. This can be explained more easily through an example. Most (if not all) languages have forms of expression that are not appropriate for all audiences. For example, in English one would not address the President of the United States in the same informal way as one would address a close friend (*“How is your day going, Mr. President?”* versus *“Hey dude, whazzup?”*). The meaning of the utterance expressed to these two individuals may be the same, but the words and intonation are somewhat different. If an international student were learning English, it would be important for the language teacher to communicate not only the meaning of the words (intrinsic load) but also the contexts in which those words are appropriate (germane load). Learning the situations in which certain phrases are most appropriately used goes beyond intrinsic load but could hardly be considered extraneous if one's purpose is to learn the language well.

It goes without saying that beginning learners should not be exposed to germane cognitive load; the intrinsic load for many tasks is of sufficient complexity that beginners cannot handle any additional processing burdens. However, as learning proceeds and the intrinsic load becomes more and more automatized, teachers can add aspects of additional complexity that enhance students' understanding of the material in a germane way.

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1.5 Cognitive View: Metacognition and Problem Solving

Critical thinking requires skill at analyzing the reliability and validity of information, as well as the attitude or disposition to do so. The skill and attitude may be displayed with regard to a particular subject matter or topic, but in principle it can occur in any realm of knowledge (Halpern, 2003; Williams, Oliver, & Stockade, 2004). A critical thinker does not necessarily have a negative attitude in the everyday sense of constantly criticizing someone or something. Instead, he or she can be thought of as *astute*: the critical thinker asks key questions, evaluates the evidence for ideas, reasons for problems both logically and objectively, and expresses ideas and conclusions clearly and precisely. Last (but not least), the critical thinker can apply these habits of mind in more than one realm of life or knowledge.

With such a broad definition, it is not surprising that educators have suggested a variety of specific cognitive skills as contributing to critical thinking. In one study, for example, the researcher found how critical thinking can be reflected in regard to a published article was stimulated by **annotation**—writing questions and comments in the margins of the article (Liu, 2006). In this study, students were initially instructed in ways of annotating reading materials. Later, when the students completed additional readings for assignments, it was found that some students in fact used their annotation skills much more than others—some simply underlined passages, for example, with a highlighting pen. When essays written about the readings were later analyzed, the ones written by the annotators were found to be more well reasoned—more critically astute—than the essays written by the other students.

In another study, on the other hand, a researcher found that critical thinking can also involve oral discussion of personal issues or dilemmas (Hawkins, 2006). In this study, students were asked to verbally describe a recent, personal incident that disturbed them. Classmates then discussed the incident together in order to identify the precise reasons why the incident was disturbing, as well as the assumptions that the student made in describing the incident. The original student—the one who had first told the story—then used the results of the group discussion to frame a topic for a research essay. In one story of a troubling incident, a student told of a time when a store clerk has snubbed or rejected the student during a recent shopping errand. Through discussion, classmates decided that an assumption underlying the student's disturbance was her suspicion that she had been a victim of racial profiling based on her skin color. The student then used this idea as the basis for a research essay on the topic of "racial profiling in retail stores". The oral discussion thus stimulated critical thinking in the student and the classmates, but it also *relied* on their prior critical thinking skills at the same time.

Notice that in both of these research studies, as in others like them, what made the thinking "critical" was students' use of **metacognition**—strategies for thinking *about* thinking and for monitoring the success and quality of one's own thinking. When students acquire experience in building their own knowledge, they also become skilled both at knowing *how* they learn, and at knowing *whether* they have learned something well. These are two defining qualities of metacognition, but they are part of critical thinking as well. In fostering critical thinking, a teacher is really fostering a student's ability to construct or control his or her own thinking and to avoid being controlled by ideas unreflectively.

How best to teach critical thinking remains a matter of debate. One issue is whether to infuse critical skills into existing courses or to teach them through separate, free-standing units or courses. The first approach has the potential advantage of integrating critical thinking into students' entire educations. But it risks diluting students' understanding and use of critical thinking simply because critical thinking takes on a different form in each learning context. Its details and appearance vary among courses and teachers. The free-standing approach has the opposite qualities: it stands a better chance of being understood clearly and coherently, but at the cost of obscuring how it is related to other courses, tasks, and activities. This dilemma is the issue—again—of transfer. Unfortunately, research to compare the different strategies for teaching critical thinking does not settle the matter. The research suggests simply that either infusion or free-standing approaches can work as long as it is implemented thoroughly and teachers are committed to the value of critical thinking (Halpern, 2003).

A related issue about teaching critical thinking is about deciding who needs to learn critical thinking skills the most. Should it be all students, or only some of them? Teaching all students seems the more democratic alternative and thus appropriate for educators. Surveys have found, however, that teachers sometimes favor teaching of critical thinking only to high-advantage students—the ones who already achieve well, who come from relatively high-income families, or (for high school students) who take courses intended for university entrance (Warburton & Torff, 2005). Presumably the rationale for this bias is that high-advantage students can benefit and/or understand and use critical thinking better than other students. Yet, there is little research evidence to support this idea, even if it were not ethically questionable. The study by Hawkins (2006) described above, for example, is that critical thinking was fostered even with students considered low-advantage.

Problem-solving

Somewhat less open-ended than creative thinking is **problem solving**, the analysis and solution of tasks or situations that are complex or ambiguous and that pose difficulties or obstacles of some kind (Mayer & Wittrock, 2006). Problem solving is needed, for example, when a physician analyzes a chest X-ray: a photograph of the chest is far from clear and requires skill, experience, and resourcefulness to decide which foggy-looking blobs to ignore, and which to interpret as real physical structures (and therefore real medical concerns). Problem solving is also needed when a grocery store manager has to decide how to improve the sales of a product: should she put it on sale at a lower price, or increase publicity for it, or both? Will these actions actually increase sales enough to pay for their costs?

Problem solving in the classroom

Problem solving happens in classrooms when teachers present tasks or challenges that are deliberately complex and for which finding a solution is not straightforward or obvious. The responses of students to such problems, as well as the strategies for assisting them, show the key features of problem solving. Consider this example, and students' responses to it. We have numbered and named the paragraphs to make it easier to comment about them individually:

Scene #1: a problem to be solved

A teacher gave these instructions: "Can you connect all of the dots below using only four straight lines?" She drew the following display on the chalkboard:

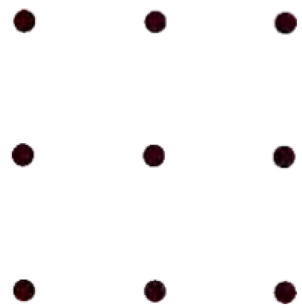

Figure 1.3 The teacher gave these instructions: "Can you connect these dots with only four lines

The problem itself and the procedure for solving it seemed very clear: simply experiment with different arrangements of four lines. But two volunteers tried doing it at the board, but were unsuccessful. Several others worked at it at their seats, but also without success.

Scene #2: coaxing students to re-frame the problem

When no one seemed to be getting it, the teacher asked, "Think about how you've set up the problem in your mind—about what you believe the problem is about. For instance, have you made any assumptions about how long the lines ought to be? Don't stay stuck on one approach if it's not working!"

Scene #3: Alicia abandons a fixed response

After the teacher said this, Alicia indeed continued to think about how she saw the problem. "The lines need to be no longer than the distance across the square," she said to herself. So she tried several more solutions, but none of them worked either.

The teacher walked by Alicia's desk and saw what Alicia was doing. She repeated her earlier comment: "Have you assumed anything about how long the lines ought to be?"

Alicia stared at the teacher blankly, but then smiled and said, "Hmm! You didn't actually say that the lines could be no longer than the matrix! Why not make them longer?" So she experimented again using oversized lines and soon discovered a solution:

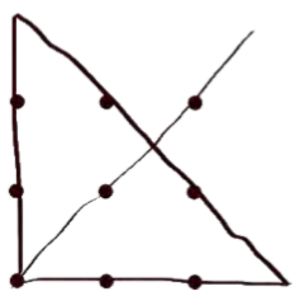

Figure 1.4 Alicia's solution

Scene #4: Willem's and Rachel's alternative strategies

Meanwhile, Willem worked on the problem. As it happened, Willem loved puzzles of all kinds, and had ample experience with them. He had not, however, seen this particular problem. "It **must** *be a trick," he said to himself, because he knew from experience that problems posed in this way often were not what they first appeared to be. He mused to himself: "Think outside the box, they always tell you…" And* **that** *was just the hint he needed: he drew lines outside the box by making them longer than the matrix and soon came up with this solution:*

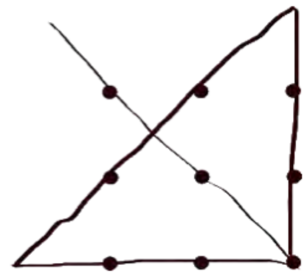

Figure 1.5 Willem's and Rachel's solution

When Rachel went to work, she took one look at the problem and knew the answer immediately: she had seen this problem before, though she could not remember where. She had also seen other drawing-related puzzles, and knew that their solution always depended on making the lines longer, shorter, or differently angled than first expected. After staring at the dots briefly, she drew a solution faster than Alicia or even Willem. Her solution looked exactly like Willem's.

This story illustrates two common features of problem solving: the effect of degree of structure or constraint on problem solving, and the effect of mental obstacles to solving problems. The next sections discuss each of these features, and then looks at common techniques for solving problems.

The effect of constraints: well-structured versus ill-structured problems

Problems vary in how much information they provide for solving a problem, as well as in how many rules or procedures are needed for a solution. A **well-structured problem** provides much of the information needed and can in principle be solved using relatively few clearly understood rules. Classic examples are the word problems often taught in math lessons or classes: everything you need to know is contained within the stated problem and the solution procedures are relatively clear and precise. An **ill-structured problem** has the converse qualities: the information is *not* necessarily within the problem, solution procedures are potentially quite numerous, and a multiple solutions are likely (Voss, 2006). Extreme examples are problems like "How can the world achieve lasting peace?" or "How can teachers insure that students learn?"

By these definitions, the nine-dot problem is relatively well-structured—though not completely. Most of the information needed for a solution is provided in *Scene #1:* there are nine dots shown and instructions given to draw four lines. But not *all* necessary information was given: students needed to consider lines that were longer than implied in the original statement of the problem. Students had to "think outside the box", as Willem said—in this case, literally.

When a problem is well-structured, so are its solution procedures likely to be as well. A well-defined procedure for solving a particular kind of problem is often called an **algorithm;** examples are the procedures for multiplying or dividing two numbers or the instructions for using a computer (Leiserson, et al., 2001). Algorithms are only effective when a problem is very well-structured and there is no question about whether the algorithm is an appropriate choice for the problem. In that situation it pretty much guarantees a correct solution. They do not work well, however, with ill-structured problems, where they are ambiguities and questions about how to proceed or even about precisely *what* the problem is about. In those cases it is more effective to use **heuristics,** which are general strategies—"rules of thumb", so to speak—that do not always work, but often do, or that provide at least partial solutions. When beginning research for a term paper, for example, a useful heuristic is to scan the library catalogue for titles that look relevant. There is no guarantee that this strategy will yield the books most needed for the paper, but the strategy works enough of the time to make it worth trying.

In the nine-dot problem, most students began in Scene #1with a simple algorithm that can be stated like this: "Draw one line, then draw another, and another, and another". Unfortunately this simple procedure did not produce a solution, so they had to find other strategies for a solution. Three alternatives are described in Scenes #3 (for Alicia) and 4 (for Willem and Rachel). Of these, Willem's response resembled a heuristic the most: he knew from experience that a good *general* strategy that *often* worked for such problems was to suspect a deception or trick in how the problem was originally stated. So he set out to question what the teacher had meant by the word *line,* and came up with an acceptable solution as a result.

Common obstacles to solving problems

The example also illustrates two common problems that sometimes happen during problem solving. One of these is **functional fixedness:** a tendency to regard the *functions* of objects and ideas as *fixed* (German & Barrett, 2005). Over time, we get so used to one particular purpose for an object that we overlook other uses. We may think of a dictionary, for example, as necessarily something to verify spellings and definitions, but it also can function as a gift, a doorstop, or a footstool. For students working on the nine-dot matrix described in the last section, the notion of "drawing" a line was also initially fixed; they assumed it to be connecting dots but not extending lines beyond the dots. Functional fixedness falls under the larger category of **response set**, the tendency for a person to frame or think about each problem in a series in the same way as the previous problem, even when doing so is not appropriate to later problems. In the example of the nine-dot matrix described above, students often tried one solution after another, but each solution was constrained by a response set *not* to extend any line beyond the matrix.

Functional fixedness and the response set are obstacles in problem representation, the way that a person understands and organizes information provided in a problem. If information is misunderstood or used inappropriately, then mistakes are likely—if indeed the problem can be solved at all. With the nine-dot matrix problem, for example, construing the instruction to draw four lines as meaning "draw four lines entirely within the matrix" means that the problem simply could not be solved. For another, consider this problem: "The number of water lilies on a lake doubles each day. Each water lily covers exactly one square foot. If it takes 100 days for the lilies to cover the lake exactly, how many days does it take for the lilies to cover exactly *half* of the lake?" If you think that the size of the lilies affects the solution to this problem, you have not represented the problem correctly. Information about lily size is *not* relevant to the solution, and only serves to distract from the truly crucial information, the fact that the lilies *double* their coverage each day. (The answer, incidentally, is that the lake is half covered in 99 days; can you think why?)

Strategies to assist problem solving

Just as there are cognitive obstacles to problem solving, there are also general strategies that help the process be successful, regardless of the specific content of a problem (Thagard, 2005). One helpful strategy is **problem analysis**—identifying the parts of the problem and working on each part separately. Analysis is especially useful when a problem is ill-structured. Consider this problem, for example: "Devise a plan to improve bicycle transportation in the city." Solving this problem is easier if you identify its parts or component subproblems, such as (1) installing bicycle lanes on busy streets, (2) educating cyclists and motorists to ride safely, (3) fixing potholes on streets used by cyclists, and (4) revising traffic laws that interfere with cycling. Each separate subproblem is more manageable than the original, general problem. The solution of each subproblem contributes the solution of the whole, though of course is not equivalent to a whole solution.

Another helpful strategy is **working backward** *from* a final solution *to* the originally stated problem. This approach is especially helpful when a problem is well-structured but also has elements that are distracting or misleading when approached in a forward, normal direction. The water lily problem described above is a good example: starting with the day when *all* the lake is covered (Day 100), ask what day would it therefore be *half* covered (by the terms of the problem, it would have to be the day before, or Day 99). Working backward in this case encourages reframing the extra information in the problem (i. e. the size of each water lily) as merely distracting, not as crucial to a solution.

A third helpful strategy is **analogical thinking**—using knowledge or experiences with similar features or structures to help solve the problem at hand (Bassok, 2003). In devising a plan to improve bicycling in the city, for example, an analogy of cars with bicycles is helpful in thinking of solutions: improving conditions for both vehicles requires many of the same measures (improving the roadways, educating drivers). Even solving simpler, more basic problems is helped by considering analogies. A first grade student can partially decode unfamiliar printed words by analogy to words he or she has learned already. If the child cannot yet read the word *screen,* for example, he can note that part of this word looks similar to words he may already know, such as *seen* or *green,* and from this observation derive a clue about how to read the word *screen.* Teachers can assist this process, as you might expect, by suggesting reasonable, helpful analogies for students to consider.

Solutions

2 Motivation

2.1 Motivation: Behavioral and Attribution Theories

What Is Motivation?

Motivation (http://teachingedpsych.wikispaces.com/Selected+Key+Concepts+and+Examples+of+Motivation) —the energy or drive that gives behavior direction and focus—can be understood in a variety of ways, each of which has implications for teaching. Since modern education is compulsory, teachers cannot take students' motivation for granted, and they have a responsibility to ensure students' motivation to learn. Somehow or other, teachers must persuade students to want to do what students have to do anyway. This task—understanding and therefore influencing students' motivations to learn—is the focus of this chapter. Fortunately, as you will see, there are ways of accomplishing this task that respect students' choices, desires, and attitudes. Like motivation itself, theories of it are full of diversity.

One perspective on motivation comes from behaviorism, and equates underlying drives or motives with their outward, visible expression in behavior. Most others, however, come from cognitive theories of learning and development. Motives are affected by the kind of goals set by students—whether they are oriented to mastery, performance, failure avoidance, or social contact. They are also affected by students' interests, both personal and situational. And they are affected by students' attributions about the causes of success and failure—whether they perceive the causes are due to ability, effort, task difficulty, or luck.

A major current perspective about motivation is based on self-efficacy theory, which focuses on a person's belief that he or she is capable of carrying out or mastering a task. High self-efficacy affects students' choice of tasks, their persistence at tasks, and their resilience in the face of failure. It helps to prevent learned helplessness, a perception of complete lack of control over mastery or success. Teachers can encourage high self-efficacy beliefs by providing students with experiences of mastery and opportunities to see others' experiences of mastery, by offering well-timed messages persuading them of their capacity for success, and by interpreting students' emotional reactions to success, failure and stress.

An extension of self-efficacy theory is expectancy-value theory, which posits that our motivation for a specific task is a combination of our expectation of success and how important or valuable the task is to us. Yet another related idea is self-determination theory, which is based on the concept that everyone has basic needs for autonomy, competence, and relatedness to others. According to the theory, students will be motivated more intrinsically if these three needs are met as much as possible. A variety of strategies can assist teachers in meeting these needs.

Behavioral Views of Motivation

Sometimes it is useful to think of motivation not as something "inside" a student driving the student's behavior, but as *equivalent* to the student's outward behaviors. This is the perspective of behaviorism. In its most orthodox form, behaviorism focuses almost completely on what can be directly seen or heard about a person's behavior, and has relatively few comments about what may lie behind (or "underneath" or "inside") the behavior. When it comes to motivation, this perspective means minimizing or even ignoring the distinction between the inner drive or energy of students, and the outward behaviors that express the drive or energy. The two are considered the same, or nearly so.

Equating the inner and the outward might seem to violate common sense. How can a student do something without some sort of feeling or thought to make the action happen? As we will explain, this very question has led to alternative models of motivation that are based on cognitive rather than behaviorist theories of learning. We will explain some of these later in this chapter. Before getting to them, however, we encourage you to consider the advantages of a behaviorist perspective on motivation.

Sometimes the circumstances of teaching limit teachers' opportunities to distinguish between inner motivation and outward behavior. Certainly teachers see plenty of student behaviors — signs of motivation of some sort. But the multiple demands of teaching can limit the time needed to determine what the behaviors mean. If a student asks a lot of questions during discussions, for example, is he or she curious about the material itself, or just wanting to look intelligent in front of classmates and the teacher? In a class with many students and a busy agenda, there may not be a lot of time for a teacher to decide between these possibilities. In other cases, the problem may not be limited time as much as communication difficulties with a student. Consider a student who is still learning English, or who belongs to a cultural community that uses patterns of conversation that are unfamiliar to the teacher, or who has a disability that limits the student's general language skill. In these cases discerning the student's inner motivations may take more time and effort. It is important to invest the extra time and effort for such students, but while a teacher is doing so, it is also important for her to guide and influence the students' behavior in constructive directions. That is where behaviorist approaches to motivation can help.

Operant conditioning as a way of motivating

The most common version of the behavioral perspective on motivation is the theory of *operant conditioning* associated with B. F. Skinner (1938, 1957). Behaviorism is a theory of learning, but the same operant model can be transformed into an account of motivation. In the operant model, you may recall, a behavior being learned (the "operant") increases in frequency or likelihood because performing it makes a reinforcement available. To understand this model in terms of motivation, think of the *likelihood* of response as the motivation and the *reinforcement* as the motivator. Imagine, for example, that a student learns by operant conditioning to answer questions during class discussions: each time the student answers a question (the operant), the teacher praises (reinforces) this behavior.

In addition to thinking of this situation as behavioral *learning*, however, you can also think of it in terms of *motivation:* the likelihood of the student answering questions (the motivation) is increasing because of the teacher's praise (the motivator). Many concepts from operant conditioning, in fact, can be understood in motivational terms. Another one, for example, is the concept of extinction (http://cnx.org/content/m43357/latest/#import-auto-id1167817862357) , a sort of "unlearning", or at least a decrease in performance of previously learned. The decrease in performance frequency can be thought of as a loss of motivation, and removal of the reinforcement can be thought of as removal of the motivator. The following table summarizes this way of reframing operant conditioning in terms of motivation, both for the concepts discussed in the Behavioral Approaches module and for other additional concepts.

Table 2.1 Operant conditioning as learning and as motivation

Concept	Definition phrased in terms of learning	Definition phrased in terms of motivation	Classroom example
Operant	Behavior that becomes more likely because of reinforcement	Behavior that suggests an increase in motivation	Student listens to teacher's comments during lecture or discussion
Reinforcement	Stimulus that increases likelihood of a behavior	Stimulus that motivates	Teacher praises student for listening
Positive reinforcement	Stimulus that *increases* likelihood of a behavior by being *introduced* or *added* to a situation	Stimulus that motivates by its *presence*; an "incentive"	Teacher makes encouraging remarks about student's homework
Negative reinforcement	Stimulus that *increases* the likelihood of a behavior by being *removed* or taken away from a situation	Stimulus that motivates by its *absence* or *avoidance*	Teacher cancels a quiz after students turn in homework every day this week
Punishment	Stimulus that *decreases* the likelihood of a behavior by being *introduced* or *added* to a situation	Stimulus that *decreases* motivation by its *presence*	Teacher deducts points for late homework
Extinction	Removal of reinforcement for a behavior	Removal of motivating stimulus that leads to decrease in motivation	Teacher stops commenting altogether about student's homework
Shaping successive approximations	Reinforcements for behaviors that gradually resemble (approximate) a final goal behavior	Stimuli that gradually shift motivation toward a final goal motivation	Teacher praises student for returning homework a bit closer to the deadline; gradually she only praises for actually being on time
Continuous reinforcement	Reinforcement that occurs *each* time that an operant behavior occurs	Motivator that occurs *each* time that a behavioral sign of motivation occurs	Teacher praises highly active student for *every* time he works for five minutes without interruption
Intermittent reinforcement	Reinforcement that *sometimes* occurs following an operant behavior, but not on every occasion	Motivator that occurs *sometimes* when a behavioral sign of motivation occurs, but not on every occasion	Teacher praises highly active student *sometimes* when he works without interruption, but not every time

Cautions about behavioral perspectives on motivation

As mentioned earlier, behaviorist perspectives about motivation do reflect a classroom reality: that teachers sometimes lack time and therefore must focus simply on students' appropriate outward behavior. But there are nonetheless cautions about adopting this view. An obvious one is the ambiguity of students' specific behaviors; what looks like a sign of one motive to the teacher may in fact be a sign of some other motive to the student (DeGrandpre, 2000). If a student looks at the teacher intently while she is speaking, does it mean the student is motivated to learn, or only that the student is daydreaming? If a student invariably looks away while the teacher is speaking, does it mean that the student is disrespectful of the teacher, or that student comes from a family or cultural group where *avoiding* eye contact actually shows more respect for a speaker than direct eye contact?

Another concern about behaviorist perspectives, including operant conditioning, is that it leads teachers to ignore students' choices and preferences, and to "play God" by making choices on their behalf (Kohn, 1996). According to this criticism, the distinction between "inner" motives and expressions of motives in outward behavior does not disappear just because a teacher (or a psychological theory) chooses to treat a motive and the behavioral expression of a motive as equivalent. Students usually *do* know what they want or desire, and their wants or desires may not always correspond to what a teacher chooses to reinforce or ignore. This, in a new guise, is once again the issue of intrinsic (http://cnx.org/content/m43357/latest/#import-auto-id1167817879810) versus extrinsic (http://cnx.org/content/m43357/latest/#import-auto-id1167817880631) motivation. Approaches that are exclusively behavioral, it is argued, are not sensitive enough to students' *intrinsic*, self-sustaining motivations. Click here (http://teachingedpsych.wikispaces.com/Do+Rewards+Motivate+Students%3F) for several perspectives on this ongoing debate.

There is truth to this allegation if a teacher actually does rely on rewarding behaviors that she alone has chosen, or even if she persists in reinforcing behaviors that students already find motivating without external reinforcement. In those cases reinforcements can backfire: instead of serving as an incentive to desired behavior, reinforcement can become a reminder of the teacher's power and of students' lack of control over their own actions. A classic research study of intrinsic motivation illustrated the problem nicely. In the study, researchers rewarded university students for two activities—solving puzzles and writing newspaper headlines —that they already found interesting. Some of the students, however, were *paid* to do these activities, whereas others were not. Under these conditions, the students who were paid were *less* likely to engage in the activities following the experiment than were the students who were not paid, even though both groups had been equally interested in the activities to begin with (Deci, 1971). The extrinsic reward of payment, it seemed, interfered with the intrinsic reward of working the puzzles.

In another study, early adolescents studying nutrition topics were told that learning the material would enhance either their physical appearance, an extrinsic goal focus, or health, an intrinsic goal focus (Vansteenkiste, Simons, Lens, Soenens, & Matos, L., 2005). Those students focusing on the extrinsic goal did better on tests of rote learning while those focusing on the intrinsic goal did better on conceptual learning. In other words, extrinsic goals appear to promote superficial strategies such as memorization, while intrinsic goals seem to enhance deeper learning (Vansteenkiste, et al., 2005).

Many studies have confirmed these effects in numerous situations, though they have also found certain conditions where extrinsic rewards (http://cnx.org/content/m43357/latest/#import-auto-id1167817880631) do *not* reduce intrinsic rewards. Extrinsic rewards are not as harmful, for example, if a person is paid "by the hour" (i.e. by a flat rate) rather than piecemeal (by the number of items completed) (Cameron & Pierce, 1994; Eisenberger & Cameron, 1996). They also are less harmful if the task itself is relatively well-defined (like working math problems or playing solitaire) and high-quality performance is expected at all times. So there are still times and ways when externally determined reinforcements are useful and effective. In general, however, extrinsic rewards do seem to undermine intrinsic motivation often enough that they need to be used selectively and thoughtfully (Deci, Koestner, & Ryan, 2001). As it happens, help with being selective and thoughtful can be found in the other, more cognitively oriented theories of motivation. These use the goals, interests, and beliefs of students as ways of explaining differences in students' motives and in how the motives affect engagement with school.

Motives related to attributions

Attributions are perceptions about the causes of success and failure. Suppose that you get a low mark on a test and are wondering what caused the low mark. You can construct various explanations for—make various attributions about—this failure. Maybe you did not study very hard; maybe the test itself was difficult; maybe you were unlucky; maybe you just are not smart enough. Each explanation attributes the failure to a different factor. The explanations that you settle upon may reflect the truth accurately—or then again, they may not. What is important about attributions is that they reflect personal beliefs about the sources or causes of success and failure. As such, they tend to affect motivation in various ways, depending on the nature of the attribution (Weiner, 2005).

Locus, stability, and controllability

Attributions vary in three underlying ways: locus, stability, and controllability. **Locus** of an attribution is the location (figuratively speaking) of the source of success or failure. If you attribute a top score on a test to your ability or to having studied hard, then the locus is *internal;* that is, being smart and studying are factors within you. If you attribute the score to the test's having easy questions, then the locus is *external;* in other words, your success is due to something outside of you. The **stability** of an attribution is its relative permanence. If you attribute the score to your ability, then the source of success is relatively *stable*— by definition, ability is a relatively lasting quality. If you attribute a top score to the effort you put in to studying, then the source of success is *unstable*— effort can vary and has to be renewed on each occasion or else it disappears. The **controllability** of an attribution is the extent to which the individual can influence it. If you attribute a top score to your effort at studying, then the source of success is relatively *controllable*— you can influence effort simply by deciding how much to study. But if you attribute the score to simple luck, then the source of the success is *uncontrollable*— there is nothing that can influence random chance.

	Internal	External
Stable	Personal traits Ability Work ethic Study habits	Task difficulty Teacher bias
Unstable	Fatigue Illness Temporary effort (specific to task)	Luck Chance Fate Lack of help Reaction to characteristics of the specific situation

Figure 2.1 Attributions for Success and Failure Note: Attributions in green are uncontrollable; attributions in purple are controllable. (Weiner, 1992)

As you might suspect, the way that these attributions combine affects students' academic motivations in major ways. It usually helps both motivation and achievement if a student attributes academic successes and failures to factors that are internal and controllable, such as effort or a choice to use particular learning strategies (Dweck, 2000). Attributing successes to factors that are internal but stable or controllable (like ability), on the other hand, is both a blessing and a curse: sometimes it can create optimism about prospects for future success ("I always do well"), but it can also lead to indifference about correcting mistakes (Dweck, 2006), or even create pessimism if a student happens not to perform at the accustomed level ("Maybe I'm not as smart as I thought"). Worst of all for academic motivation are attributions, whether stable or not, related to external factors. Believing that performance depends simply on luck ("The teacher was in a bad mood when marking") or on excessive difficulty of material removes incentive for a student to invest in learning. All in all, then, it seems important for teachers to encourage internal, controllable attributions about success.

Influencing students' attributions

How can they do so? One way or another, the effective strategies involve framing teachers' own explanations of success and failure around internal, controllable factors. Instead of telling a student: "Good work! You're smart!", try saying: "Good work! Your effort really made a difference, didn't it?" If a student fails, instead of saying,"Too bad! This material is just too hard for you," try saying, "Let's find a strategy for practicing this more, and then you can try again." In both cases the first option emphasizes uncontrollable factors (effort, difficulty level), and the second option emphasizes internal, controllable factors (effort, use of specific strategies).

Such attributions will only be convincing, however, if teachers provide appropriate conditions for students to learn—conditions in which students' efforts really do pay off. There are three conditions that have to be in place in particular. First, academic tasks and materials actually have to be at about the right level of difficulty. If you give problems in advanced calculus to a first-grade student, the student will not only fail them but also be justified in attributing the failure to an external factor, task difficulty. If assignments are assessed in ways that produce highly variable, unreliable marks, then students will rightly attribute their performance to an external, unstable source: luck. Both circumstances will interfere with motivation.

Second, teachers also need to be ready to give help to individuals who need it—even if they believe that an assignment is easy enough or clear enough that students should not need individual help. Readiness to help is always essential because it is often hard to know in advance exactly how hard a task will prove to be for particular students. Without assistance, a task that proves difficult initially may remain difficult indefinitely, and the student will be tempted to make unproductive, though correct, attributions about his or her failure ("I will never understand this", "I'm not smart enough", or "It doesn't matter how hard I study").

Third, teachers need to remember that ability—usually considered a relatively stable factor—often actually changes *incrementally* over the long term. Recognizing this fact is one of the best ways to bring about actual increases in students' abilities (Blackwell, Trzniewski, & Dweck, 2007; Schunk, Pintrich, & Meese, 2008). A middle-years student might play the trumpet in the school band at a high level of ability, but this ability actually reflects a lot of previous effort and a gradual increase in ability. A second grade student who reads fluently, in this sense may have high current ability to read; but at some point in the distant past that same student could not read as well, and even further back he may not have been able to read at all. The increases in ability have happened at least in part because of effort. While these ideas may seem obvious, they can easily be forgotten in the classroom because effort and ability evolve according to very different time frames. Effort and its results appear relatively immediately; a student expends effort this week, this day, or even at this very moment, and the effort (if not the results) are visible right away. But ability may take longer to show itself; a student often develops it only over many weeks, months, or years.

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Much of the material from this topic was adapted from Seifert and Sutton (2011).

2.2 Motivation: Self-Efficacy and Expectancy-Value

Self-Efficacy

In addition to being influenced by their goals, interests, and attributions (http://cnx.org/content/m43357/latest/#import-auto-id1167817869326) , students' motives are affected by *specific* beliefs about the student's personal capacities. In **self-efficacy theory** the beliefs become a primary, explicit explanation for motivation (Bandura, 1977, 1986, 1997). **Self-efficacy** is an individual's belief that he/she is capable of carrying out a specific task or of reaching a specific goal. Note that the belief and the action or goal are *specific*. Your self-efficacy is your beliefs about whether or not you can write an acceptable term paper, for example, or repair an automobile, or make friends with the new student in class. These are relatively specific beliefs and tasks. Self-efficacy is not about whether you believe that you are intelligent in general, whether you always like working with mechanical things, or think that you are generally a likeable person. These more general judgments are better regarded as various mixtures of *self-concepts* (beliefs about general personal identity) or of *self-esteem* (evaluations of identity). They are important in their own right, and sometimes influence motivation, but only indirectly (Bong & Skaalvik, 2004).

Self-efficacy beliefs, furthermore, are not the same as "true" or documented skill or ability. They are *self-* constructed, meaning that they are personally developed perceptions. There can sometimes therefore be discrepancies between a person's self-efficacy beliefs and the person's abilities. You can believe that you can write a good term paper, for example, without actually being able to do so, and vice versa: you can believe yourself *in*capable of writing a paper, but discover that you *are* in fact able to do so. In this way self-efficacy is like the everyday idea of *confidence*, except that it is defined more precisely. And as with confidence, it is possible to have either too much or too little self-efficacy. The optimum level seems to be either at or slightly above true capacity (Bandura, 1997). As we indicate below, large discrepancies between self-efficacy and ability can create motivational problems for the individual.

Effects of self-efficacy on students' behavior

Self-efficacy may sound like a uniformly desirable quality, but research as well as teachers' experience suggests that its effects are a bit more complicated than they first appear. Self-efficacy has three main effects, each of which has both a negative or undesirable side and a positive or desirable side.

Choice of tasks

The first effect is that self-efficacy makes students more willing to choose tasks where they already feel confident of succeeding. While this seems intuitive, given the definition of the concept of self-efficacy, it has also been supported by research on self-efficacy beliefs (Pajares & Schunk, 2001). For teachers, the effect on choice can be either welcome or not, depending on circumstances. If a student believes that he or she can solve mathematical problems, then the student is more likely to attempt the mathematics homework that the teacher assigns.

Unfortunately the converse is also true. If a student believes that he or she is *in* capable of math, then the student is *less* likely to attempt the math homework (perhaps telling himself, "What's the use of trying?"), regardless of the student's actual ability in math.

Since self-efficacy is self-constructed, furthermore, it is also possible for students to miscalculate or misperceive their true skill, and the misperceptions themselves can have complex effects on students' motivations. From a teacher's point of view, all is well even if students overestimate their capacity but actually do succeed at a relevant task anyway, or if they underestimate their capacity, yet discover that they *can* succeed and raise their self-efficacy beliefs as a result. All may not be well, though, if students do not believe that they can succeed and therefore do not even try, or if students overestimate their capacity by a wide margin, but are disappointed unexpectedly by failure and lower their self-efficacy beliefs.

Persistence at tasks

A second effect of high self-efficacy is to increase persistence at relevant tasks. If you believe that you can solve crossword puzzles, but encounter one that takes longer than usual, then you are more likely to work longer at the puzzle until you (hopefully) really do solve it. This is probably a desirable behavior in many situations, unless the persistence happens to interfere with other, more important tasks (what if you should be doing homework instead of working on crossword puzzles?). If you happen to have low self-efficacy for crosswords, on the other hand, then you are more likely to give up early on a difficult puzzle. Giving up early may often be undesirable because it deprives you of a chance to improve your skill by persisting. Then again, the consequent lack of success because of giving up may provide a useful incentive to improve your crossword skills. And again, misperceptions of capacity make a difference. Overestimating your capacity by a lot (excessively high self-efficacy) might lead you not to prepare for or focus on a task properly, and thereby impair your performance. So as with choosing tasks, the effects of self-efficacy vary from one individual to another and one situation to another. The teacher's task is therefore two-fold: first, to discern the variations, and second, to encourage the positive self-efficacy beliefs. The following table offers some additional advice about how to do this.

Table 2.2 Ways of encouraging self-efficacy beliefs

Strategy	Example of what the teacher might say
1. Set goals with students, and get a commitment from them to reach the goals.	"By the end of the week, I want you to know be able to define these 5 terms. Can I count on you to do that?"
2. Encourage students to compare their performance with their own previous performance, not with other students.	"Compare that drawing against the one that you made last semester. I think you'll find improvements!"
3. Point out links between effort and improvement.	"I saw you studying for this test more this week. No wonder you did better this time!"
4. In giving feedback about performance, focus on information, not evaluative judgments.	"Part 1 of the lab write-up was very detailed, just as the assignment asked. Part 2 has a lot of good ideas in it, but it needs to be more detailed and stated more explicitly."
5. Point out that increases in knowledge or skill happen gradually by sustained effort, not because of inborn ability.	"Every time I read another one of your essays, I see more good ideas than the last time. They are so much more complete than when you started the year."

Example 2.1 Self-Efficacy, Illustrated (http://www.coe.uga.edu/epltt/images/swiftpieefficacy.swf)

This flash animation illustrates the journey of a teacher and student as the student's self-efficacy increases. Sammy has low self-esteem, but his teacher sees a teachable moment in his desire to act and sing. She employs verbal persuasion with positive statements and peer modeling by having Sammy observe another successful classmate who had the same fears. She provides Sammy with specific feedback on his performance, and Sammy has a successful experience in his tryout as a result. By Jim Stewart, Jill Weldon, Celeste Buckhalter- Pittman, and Holly Frilot.

Source: Orey (2010).

Response to failure

High self-efficacy for a task not only increases a person's persistence (http://cnx.org/content/m43357/latest/#import-auto-id1167819943833) at the task, but also improves their ability to cope with stressful conditions and to recover their motivation following outright failures. Suppose that you have two assignments—an essay and a science lab report—due on the same day, and this circumstance promises to make your life hectic as you approach the deadline. You will cope better with the stress of multiple assignments if you already believe yourself capable of doing both of the tasks, than if you believe yourself capable of doing just one of them or (especially) of doing neither. You will also recover better in the unfortunate event that you end up with a poor grade on one or even both of the tasks.

That is the good news. The bad news, at least from a teacher's point of view, is that the same resilience can sometimes also serve non-academic and non-school purposes. How so? Suppose, instead of two school assignments due on the same day, a student has only one school assignment due, but also holds a part-time evening job as a server in a local restaurant. Suppose, further, that the student has high self-efficacy for both of these tasks; he believes, in other words, that he is capable of completing the assignment as well as continuing to work at the job.

The result of such resilient beliefs can easily be a student who devotes *less* attention to school work than ideal, and who even ends up with a *lower* grade on the assignment than he or she is capable of.

Sources of self-efficacy beliefs

Psychologists who study self-efficacy have identified four major sources of self-efficacy beliefs (Pajares & Schunk, 2001, 2002). In order of importance they are (1) prior experiences of mastering tasks, (2) watching others' mastering tasks, (3) messages or "persuasion" from others, and (4) emotions related to stress and discomfort. Fortunately the first three can be influenced by teachers directly, and even the fourth can sometimes be influenced indirectly by appropriate interpretive comments from the teacher or others.

Prior experiences of mastery

Not surprisingly, past successes at a task increase students' beliefs that they will succeed again in the future. The implication of this basic fact means that teachers need to help students build a history of successes. Whether they are math problems, reading assignments, or athletic activities, tasks have to end with success more often than with failure. Note, though, that the successes have to represent mastery that is genuine or competence that is truly authentic. Success at tasks that are trivial or irrelevant do not improve self- efficacy beliefs, nor does praise for successes that a student has not really had (Erikson, 1968/1994).

As a practical matter, creating a genuine history of success is most convincing if teachers also work to broaden a student's vision of "the past." Younger students (elementary-age) in particular have relatively short or limited ideas of what counts as "past experience;" they may go back only a few occasions when forming impressions of whether they can succeed again in the future (Eccles, et al., 1998). Older students (secondary school) gradually develop longer views of their personal "pasts," both because of improvements in memory and because of accumulating a personal history that is truly longer. The challenge for working with any age, however, is to ensure that students base self-efficacy beliefs on *all* relevant experiences from their pasts, not just on selected or recent experiences.

Watching others' experiences of mastery

A second source of efficacy beliefs comes from vicarious (http://cnx.org/content/m43357/latest/#import-auto-id1167819943313) *experience of mastery*, or observing others' successes (Schunk & Zimmerman, 1997). Simply seeing someone else succeed at a task, in other words, can contribute to believing that you, too, can succeed. The effect is stronger when the observer lacks experience with the task and therefore may be unsure of his or her own ability. It is also stronger when the model is someone respected by the observer, such as a student's teacher, or a peer with generally comparable ability. Even under these conditions, though, vicarious experience is not as influential as direct experience. The reasons are not hard to imagine.

Suppose, for example, you witness both your teacher and a respected friend succeed at singing a favorite tune, but you are unsure whether you personally can sing. In that case you may feel encouraged about your own potential, but are likely still to feel somewhat uncertain of your own efficacy. If on the other hand you do *not* witness others' singing, but you have a history of singing well yourself, it is a different story. In that case you are likely to believe in your efficacy, regardless of how others perform.

All of which suggests that to a modest extent, teachers may be able to enhance students' self-efficacy by modeling success at a task or by pointing out classmates who are successful. These strategies can work because they not only show how to do a task, but also communicate a more fundamental message, the fact that the task *can* in fact be done. If students are learning a difficult arithmetic procedure, for example, you can help by demonstrating the procedure, or by pointing out classmates who are doing it. Note, though, that vicarious mastery is helpful only if backed up with real successes performed by the students themselves. It is also helpful only if the "model classmates" are perceived as truly comparable in ability. Overuse of vicarious models, especially in the absence of real success by learners, can cause learners to disqualify a model's success; students may simply decide that the model is "out of their league" in skills and is therefore irrelevant to judging their own potential.

Expectancy-Value Theory

By now, it should be clear that motivation is affected by several factors, including reinforcement for behavior, but especially also students' goals, interests, and sense of self-efficacy. The factors combine to create two general sources of motivation: students' expectation of success and the value that students place on a goal. Viewing motivation in this way is often called the expectancy-value model of motivation (Wigfield & Eccles, 2002; Wigfield, Tonk, & Eccles, 2004), and sometimes written with a multiplicative formula: expectancy x value = motivation. The relationship between expectation and value is "multiplicative" rather than additive because in order to be motivated, it is necessary for a person to have at least a modest expectation of success and to assign a task at least some positive value. If you have high expectations of success but do not value a task at all (mentally assign it a "0" value), then you will not feel motivated at all. Likewise, if you value a task highly but have no expectation of success about completing it (assign it a "0" expectancy), then you also will not feel motivated at all. Dr. Eccles explains Expectancy-Value theory in the classroom in this brief article (http://www.education.com/reference/article/expectancy-value-motivational-theory/) .

Expectancies are the result of various factors, but particularly the goals held by a student, and the student's self-efficacy (http://cnx.org/content/m43357/latest/#import-auto-id1167817828438) . A student with mastery goals (http://cnx.org/content/m43557/latest/#import-auto-id1167817861502) and strong self-efficacy for a task, for example, is likely to hold high expectations for success—almost by definition. Values are also the result of various factors, but especially students' interests and feelings of self-determination (http://cnx.org/content/m43357/latest/#import-auto-id1167817830242) . A student who has a lasting personal interest (http://cnx.org/content/m43357/latest/#import-auto-id1167817919204) in a task or topic and is allowed to choose it freely is especially likely to value the task—and therefore to feel motivated.

Ideally both expectancies and values are high in students on any key learning task. The reality, however, is that students sometimes do not expect success, nor do they necessarily value it when success is possible. How can a teacher respond to low expectations and low valuing? A number of suggestions to meet this challenge have been offered in conjunction with discussions of other theories of motivation. In brief, raising low expectations depends on adjusting task difficulty so that success becomes a reasonable prospect: a teacher must make tasks neither too hard nor too easy. Reaching this general goal depends in turn on thoughtful, appropriate planning—selecting reasonable objectives, adjusting them on the basis of experience, finding supportive materials, and providing students with help when needed.

Raising the value of academic tasks is equally important, but the general strategies for doing so are different than for raising expectations. Increasing value requires linking the task to students' personal interests and prior knowledge, showing the utility of the task to students' future goals, and showing that the task is valuable to other people whom students' respect.

A caution: Motivation as content versus motivation as process

A caution about self-efficacy theory is its heavy emphasis on just the process of motivation, at the expense of the content of motivation. The basic self- efficacy model has much to say about how beliefs affect behavior, but relatively little to say about which beliefs and tasks are especially satisfying or lead to the greatest well-being in students. The answer to this question is important to know, since teachers might then select tasks as much as possible that are intrinsically satisfying, and not merely achievable.

Another way of posing this concern is by asking: "Is it possible to feel high self-efficacy about a task that you do not enjoy?" It does seem quite possible for such a gap to exist. A young child may show some promise as a pianist, for example. Given encouragement (pressure?) from her parents, her successes lead to further practice. She may persist in developing as a pianist, her beliefs in her skills propelling her to commit more and more time to practice and a high level of performance. But, it is possible that this girl does not particularly like playing the piano; perhaps she does it to please her parents. From a motivational perspective, self-efficacy (the girl's confidence in her skills as a pianist) explains her persistence and effort, but does not tell the full story. Accounting for such a gap requires a different theory of motivation, one that includes not only specific beliefs, but "deeper" personal needs as well. An example of this approach is self-determination (http://cnx.org/content/m43357/latest/#import-auto-id1167817830242) theory.

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Much of the material from this topic was adapted from (Seifert and Sutton, 2011).

2.3 Motivation: Goal-Setting

Motives as Goals

One way motives vary is by the kind of goals that students set for themselves, and by how the goals support students' academic achievement. As you might suspect, some goals encourage academic achievement more than others, but even motives that do not concern academics explicitly tend to affect learning indirectly.

Goals that contribute to achievement

What kinds of achievement goals do students hold? Imagine three individuals, Maria, Sara, and Lindsay, who are taking algebra together. Maria's main concern is to learn the material as well as possible because she finds it interesting and because she believes it will be useful to her in later courses, perhaps at university. Hers is a mastery goal because she wants primarily to learn or master the material. Sara, however, is concerned less about algebra than about getting top marks on the exams and in the course. Hers is a performance goal because she is focused primarily on looking successful; learning algebra is merely a vehicle for performing well in the eyes of peers and teachers. Lindsay, for her part, is primarily concerned about avoiding a poor or failing mark. Hers is a performance-avoidance (http://cnx.org/content/m43357/latest/#tick) goal because she is not really as concerned about learning algebra, as Maria is, or about competitive success, as Sara is; she is simply intending to avoid failure.

As you might imagine, mastery and performance goals often are not experienced in pure form, but in combinations. If you play the clarinet in the school band, you might want to improve your technique simply because you enjoy playing as well as possible—essentially a mastery orientation. But you might also want to look talented in the eyes of classmates—a performance orientation. Another part of what you may wish, at least privately, is to avoid looking like a complete failure at playing the clarinet. One of these motives may predominate over the others, but they all may be present.

Mastery goals (http://cnx.org/content/m43357/latest/#import-auto-id1167817861502) tend to be associated with enjoyment of learning the material at hand, and in this sense represent an outcome that teachers often seek for students. By definition therefore they are a form of *intrinsic motivation.* As such mastery goals have been found to be better than performance goals at sustaining students' interest in a subject. In one review of research about learning goals, for example, students with primarily mastery orientations toward a course they were taking not only tended to express greater interest in the course, but also continued to express interest well beyond the official end of the course, and to enroll in further courses in the same subject (Harackiewicz, et al., 2002; Wolters, 2004).

Performance goals (http://cnx.org/content/m43357/latest/#import-auto-id1167820036206) , on the other hand, imply *extrinsic motivation*, and tend to show the mixed effects of this orientation. A positive effect is that students with a performance orientation do tend to get higher grades than those who express primarily a mastery orientation. The advantage in grades occurs both in the short term (with individual assignments) and in the long term (with overall grade point average when graduating). But there is evidence that performance oriented students do not actually learn material as deeply or permanently as students who are more mastery oriented (Midgley, Kaplan, & Middleton, 2001). A possible reason is that measures of performance—such as test scores—often reward relatively shallow memorization of information and therefore guide performance-oriented students away from processing the information thoughtfully or deeply. Another possible reason is that a performance orientation, by focusing on gaining recognition as the best among peers, encourages competition among peers. Giving and receiving help from classmates is thus not in the self-interest of a performance-oriented student, and the resulting isolation limits the student's learning.

Social goals

Most students need and value relationships, both with classmates and with teachers, and often (though not always) they get a good deal of positive support from the relationships. But the effects of social relationships are complex, and at times can work both for and against academic achievement. If a relationship with the teacher is important and reasonably positive, then the student is likely to try pleasing the teacher by working hard on assignments (Dowson & McInerney, 2003). Note, though, that this effect is closer to performance than mastery; the student is primarily concerned about looking good to someone else. If, on the other hand, a student is especially concerned about relationships with peers, the effects on achievement depend on the student's motives for the relationship, as well as on peers' attitudes. Desiring to be close to peers personally may lead a student to ask for help from, and give help to peers—a behavior that may support higher achievement, at least up to a point. But desiring to impress peers with skills and knowledge may lead to the opposite: as we already mentioned, the competitive edge of such a performance orientation may keep the student from collaborating, and in this indirect way reduce a student's opportunities to learn. The abilities and achievement motivation of peers themselves can also make a difference, but once again the effects vary depending on the context. Low achievement and motivation by peers affects an individual's academic motivation more in elementary school than in high school, more in learning mathematics than learning to read, and more if there is a wide *range* of abilities in a classroom than if there is a more narrow range (Burke & Sass, 2006).

In spite of these complexities, social relationships are valued so highly by most students that teachers should generally facilitate them, though also keep an eye on their nature and their consequent effects on achievement. Many assignments can be accomplished productively in groups, for example, as long as the groups are formed thoughtfully, group tasks are chosen wisely, and all members' contributions are recognized as fully as possible. Relationships can also be supported with activities that involve students or adults from another class or from outside the school, as often happens with school or community service projects. These can provide considerable social satisfaction and can sometimes be connected to current curriculum needs (Butin, 2005). But the majority of students' social contacts are likely always to come from students' own initiatives with each other in simply taking time to talk and interact. The teacher's job is to encourage these informal contacts, especially when they happen at times that support rather than interfere with learning.

Encouraging mastery goals

Even though a degree of performance orientation may be inevitable in school because of the mere presence of classmates, it does not have to take over students' academic motivation completely. Teachers can encourage mastery goals in various ways, and should in fact do so because a mastery orientation leads to more sustained, thoughtful learning, at least in classrooms, where classmates may sometimes debate and disagree with each other (Darnon, Butera, & Harackiewicz, 2006).

How can teachers do so? One way is to allow students to choose specific tasks or assignments for themselves, where possible, because their choices are more likely than usual to reflect prior personal interests (http://cnx.org/content/m43357/latest/#import-auto-id1167817919204) , and hence be motivated more intrinsically than usual. The limitation of this strategy, of course, is that students may not see some of the connections between their prior interests and the curriculum topics at hand. In that case it also helps for the teacher to look for and point out the relevance of current topics or skills to students' personal interests and goals.

Suppose, for example, that a student enjoys the latest styles of music. This interest may actually have connections with a wide range of school curriculum, such as:

- biology (because of the physiology of the ear and of hearing)
- physics or general science (because of the nature of musical acoustics)
- history (because of changes in musical styles over time)
- English (because of relationships of musical lyrics and themes with literary themes)

- world languages (because of comparisons of music and songs among cultures)

Still another way to encourage mastery orientation is to focus on students' individual effort and improvement as much as possible, rather than on comparing students' successes to each other. You can encourage this orientation by giving students detailed feedback about how they can improve performance, or by arranging for students to collaborate on specific tasks and projects rather than to compete about them, and in general by showing your own enthusiasm for the subject at hand.

Self-Determination Theory

Common sense suggests that human motivations originate from some sort of inner "need." We all think of ourselves as having various "needs," a need for food, for example, or a need for companionship—that influences our choices and activities. This same idea also forms part of some theoretical accounts of motivation, though the theories differ in the needs that they emphasize or recognize. Maslow's hierarchy of needs is an example of motivations that function like needs that influence long-term personal development. According to Maslow, individuals must satisfy physical survival needs before they seek to satisfy needs of belonging, they satisfy belonging needs before esteem needs, and so on. In theory, too, people have both deficit needs and growth needs, and the deficit needs must be satisfied before growth needs can influence behavior (Maslow, 1970). In Maslow's theory, as in others that use the concept, a need is a relatively lasting condition or feeling that requires relief or satisfaction and that tends to influence action over the long term. Some needs may decrease when satisfied (like hunger), but others may not (like curiosity). Either way, needs differ from the self-efficacy (http://cnx.org/content/m43357/latest/#import-auto-id1167817828438) beliefs, which are relatively specific and cognitive, and affect particular tasks and behaviors fairly directly.

A more recent theory of motivation based on the idea of needs is self-determination theory, proposed by the psychologists Richard Ryan and Edward Deci (2000), among others. The theory proposes that understanding motivation requires taking into account three basic human needs:

- autonomy—the need to feel free of external constraints on behavior, to feel empowered
- competence—the need to feel capable or skilled
- relatedness—the need to belong, to feel connected or involved with others

Note that these needs are all psychological, not physical; hunger and sex, for example, are not on the list. They are also about personal growth or development, not about deficits that a person tries to reduce or eliminate. Unlike food (in behaviorism) or safety (in Maslow's hierarchy), you can never get enough of autonomy, competence, or relatedness. You (and your students) will seek to enhance these continually throughout life. The key idea of self-determination theory is that when persons (such as you or one of your students) feel that these basic needs are reasonably well met, they tend to perceive their actions and choices to be intrinsically motivated or "self-determined." In that case they can turn their attention to a variety of activities that they find attractive or important, but that do not relate directly to their basic needs. Among your students, for example, some individuals might read books that you have suggested, and others might listen attentively when you explain key concepts from the unit that you happen to be teaching. If one or more basic needs are not met well, however, people will tend to feel coerced by outside pressures or external incentives. They may become preoccupied, in fact, with satisfying whatever need has not been met and thus exclude or avoid activities that might otherwise be interesting, educational, or important. If the persons are students, their learning will suffer.

Self-determination and intrinsic motivation

In proposing the importance of needs, then, self-determination theory is asserting the importance of intrinsic motivation, an idea that has come up before and that will come again later. The self-determination version of intrinsic motivation, however, emphasizes a person's perception of freedom, rather than the presence or absence of "real" constraints on action. Self-determination means a person feels free, even if the person is also operating within certain external constraints. In principle, a student can experience self-determination even if the student must, for example, live within externally imposed rules of appropriate classroom behavior. To achieve a feeling of self-determination, however, the student's basic needs must be met—needs for autonomy, competence, and relatedness. In motivating students, then, the bottom line is that teachers have an interest in helping students to meet their basic needs, and in not letting school rules or the teachers' own leadership styles interfere with or block satisfaction of students' basic needs.

"Pure" self-determination may be the ideal for most teachers and students, of course, but the reality is usually different. For a variety of reasons, teachers in most classrooms cannot be expected to meet all students' basic needs at all times. One reason is the sheer number of students, which makes it impossible to attend to every student perfectly at all times. Another reason is teachers' responsibility for a curriculum, which can require creating expectations for students' activities that sometimes conflict with students' autonomy or makes them feel (temporarily) less than fully competent.

The result from students' point of view is usually only a partial perception of self-determination, and therefore a simultaneous mix of intrinsic and extrinsic motivations. Self-determination theory recognizes this reality by suggesting that the "intrinsic-ness" of motivation is really a matter of degree, extending from highly *ex*trinsic, through various mixtures of intrinsic and extrinsic, to highly *in*trinsic (Koestner & Losier, 2004). At the extrinsic end of the scale is learning that is regulated primarily by external rewards and constraints, whereas at the intrinsic end is learning regulated primarily by learners themselves. The table below summarizes and gives examples of the various levels and their effects on motivation. By assuming that motivation is often a mix of the intrinsic and extrinsic, the job of the teacher becomes more realistic; the job is not to expect purely intrinsic motivation from students all the time, but simply to arrange and encourage motivations that are as intrinsic as possible. To do this, the teacher needs to support students' basic needs for autonomy, competence, and relatedness.

Table 2.3 Combinations of intrinsic and extrinsic motivation

Source of regulation of action	Description	Example
Very external to person	Actions regulated only by outside pressures and incentives, and controls	Student completes assignment *only* if reminded explicitly of the incentive of grades and/or negative consequences of failing
Somewhat external	Specific actions regulated internally, but without reflection or connection to personal needs	Student completes assignment independently, but only because of fear of shaming self or because of guilt about consequences of not completing assignment
Somewhat internal	Actions recognized by individual as important or as valuable as a means to a more valued goal	Student generally completes school work independently, but only because of its value in gaining admission to college
Very internal	Actions adopted by individual as integral to self-concept and to person's major personal values	Student generally completes school work independently, because being well educated is part of the student's concept of himself

Using self-determination theory in the classroom

What are some teaching strategies for supporting students' needs? Educational researchers have studied this question from a variety of directions, and the resulting best practices converge and overlap in a number of ways. For convenience, the best practices can be grouped according to the basic need that they address, beginning with the need for autonomy.

Supporting the need for autonomy

A major part of supporting autonomy is to give students *choices* wherever possible (Ryan & Lynch, 2003). The choices that encourage the greatest feelings of self-control, obviously, are ones that are about relatively major issues or that have relatively significant consequences for students, such as whom to choose as partners for a major group project. But choices also encourage some feeling of self-control even when they are about relatively minor issues, such as how to organize your desk or what kind of folder to use for storing your papers at school. It is important, furthermore, to offer choices to *all* students, including students needing explicit directions in order to work successfully; avoid reserving choices for only the best students or giving up offering choices altogether to students who fall behind or who need extra help. All students will feel more self-determined and therefore more motivated if they have choices of some sort.

Teachers can also support students' autonomy more directly by minimizing external rewards (like grades) and comparisons among students' performance, and by orienting and responding themselves to students' expressed goals and interests. In teaching elementary students about climate change, for example, you can support autonomy by exploring which aspects of this topic have *already* come to students' attention and aroused their concern. The point of the discussion would not be to find out "who knows the most" about this topic, but to build and enhance students' intrinsic motivations as much as possible. In reality, of course, it may not be possible to succeed at this goal fully—some students may simply have no interest in the topic, for example, or you may be constrained by time or resources from individualizing certain activities fully. But any degree of attention to students' individuality, as well as any degree of choice, will support students' autonomy.

Supporting the need for competence

The most obvious way to make students feel competent is by selecting activities which are challenging but nonetheless achievable with reasonable effort and assistance (Elliott, McGregor, & Thrash, 2004). Although few teachers would disagree with this idea, there are times when it is hard to put into practice, such as when you first meet a class at the start of a school year and therefore are unfamiliar with their backgrounds and interests. But there are some strategies that are generally effective even if you are not yet in a position to know the students well.

One is to emphasize activities that require active response from students. Sometimes this simply means selecting projects, experiments, discussions and the like that require students to do more than simply listen. Other times it means expecting active responses in all interactions with students, such as by asking questions that call for "divergent" (multiple or elaborated) answers. In a social studies class, for example, try asking "What are some ways we could find out more about our community?" instead of "Tell me the three best ways to find out about our community." The first question invites more divergent, elaborate answers than the second.

Another generally effective way to support competence is to respond and give feedback as immediately as possible. Tests and term papers help subsequent learning more if returned, with comments, sooner rather than later. It is important to note that feedback should be substantive and task-specific. It is not enough to write, "Good job! A-" on a student's paper, although the student would likely be happy to see it. Compare "Nice work!" with "Your use of descriptive language really engages the reader!" or "Try writing out the formula you need for the problem as soon as you read it – this will help ensure you include all of the steps." Task-specific feedback gives students information about what they did well and what they could improve upon. It keeps the focus on mastery, rather than performance, and guides their future endeavors.

In the same vein, discussions facilitate more learning if you include your own ideas in them, while still encouraging students' input. Small group and independent activities are more effective if you provide a convenient way for students to consult authoritative sources for guidance when needed, whether the source is you personally, a teaching assistant, a specially selected reading, or even a computer program. In addition, you can sometimes devise tasks that create a feeling of competence because they have a "natural" solution or ending point. Assembling a jigsaw puzzle of the community, for example, has this quality, and so does *creating* a jigsaw puzzle of the community if the students need a greater challenge.

Supporting the need to relate to others

The main way of support students' need to relate to others is to arrange activities in which students work together in ways that are mutually supportive, that recognize students' diversity, and minimize competition among individuals. Having students work together can happen in many ways. You can, for example, deliberately arrange projects that require a variety of talents; some educators call such activities "rich group work" (Cohen, 1994; Cohen, Brody, & Sapon-Shevin, 2004). In studying in small groups about medieval society, for example, one student can contribute his drawing skills, another can contribute his writing skills, and still another can contribute his dramatic skills. The result can be a multi-faceted presentation—written, visual, and oral. The groups needed for rich group work provide for students' relationships with each other, whether they contain six individuals or only two.

There are other ways to encourage relationships among students. In the jigsaw classroom (Aronson & Patnoe, 1997), for example, students work together in two phases. In the first phase, groups of "experts" work together to find information on a specialized topic. In a second phase the expert groups split up and reform into "generalist" groups containing one representative from each former expert group. In studying the animals of Africa, for example, each expert group might find information about a different particular category of animal or plant; one group might focus on mammal, another on bird, a third on reptiles, and so on. In the second phase of the jigsaw, the generalist groups would pool information from the experts to get a more well-rounded view of the topic. The generalist groups would each have an expert about mammals, for example, but also an expert about birds and about reptiles.

As a teacher, you can add to these organizational strategies by encouraging the development of your own relationships with class members. Your goal, as teacher, is to demonstrate caring and interest in your students not just as students, but as people. The goal also involves behaving as if good relationships between and among class members are not only possible, but ready to develop and perhaps even already developing. A simple tactic, for example, is to speak of "we" and "us" as much as possible, rather than speaking of "you students." Another tactic is to present cooperative activities and assignments without apology, as if they are in the best interests not just of students, but of "us all" in the classroom, yourself included.

Keeping self-determination in perspective

In certain ways self-determination theory provides a sensible way to think about students' intrinsic motivation and therefore to think about how to get them to manage their own learning. A particular strength of the theory is that it recognizes *degrees* of self-determination and bases many ideas on this reality. Most people recognize combinations of intrinsic and extrinsic motivation guiding particular activities in their own lives. We might enjoy teaching, for example, but also do this job partly to receive a paycheck. To its credit, self-determination theory also relies on a list of basic human needs—autonomy, competence, and relatedness—that relate comfortably with some of the larger purposes of education. Although these are positive features for understanding and influencing students' classroom motivation, some educators and psychologists nonetheless have lingering questions about the limitations of self-determination theory. One is whether merely providing choices actually improves students' learning, or simply improves their *satisfaction* with learning. There is evidence supporting both possibilities (Flowerday & Schraw, 2003; Deci & Ryan, 2003), and it is likely that there are teachers whose classroom experience supports both possibilities as well.

Another question is whether it is possible to *overdo* attention to students' needs—and again there is evidence for both favoring and contradicting this possibility. Too many choices can actually make anyone (not just a student) frustrated and dissatisfied with a choice the person actually *does* make (Schwartz, 2004). Clearly the number of choices given must be developmentally appropriate: adolescents can handle far more choices than can kindergartners. Furthermore, differentiating activities to students' competence levels may be challenging if students are functioning at extremely diverse levels within a single class, as sometimes happens. These are serious concerns, though in our opinion *not* serious enough to give up offering choices to students or to stop differentiating instruction altogether. In "Classroom management and the learning environment," therefore, we explain the practical basis for this opinion, by describing workable ways for offering choices and recognizing students' diversity.

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Much of the material from this topic was adapted from (Seifert and Sutton, 2011).

3 Individual Differences

3.1 Individual Differences: Learning Styles

> I'll tell you this: There are some people, and then there are others.
>
> (Anna Harris)

Anna Harris was Kelvin Seifert's grandmother as well as a schoolteacher from about 1910 to 1930. She used to make comments, like the one above, that sounded odd but that also contained a grain of wisdom. In this case her remark makes a good theme for this module—and even for teaching in general. Students do differ in a multitude of ways, both individually and because of memberships in families, communities or cultural groups. Sometimes the differences can make classroom-style teaching more challenging, but other times, as Anna Harris implied, they simply enrich classroom life. To teach students well, we need to understand the important ways that they differ among themselves, and when or how the differences really matter for their education. This module offers some of that understanding and suggests how you might use it in order to make learning effective and enjoyable for everyone, including yourself.

For convenience we will make a major distinction between differences among individuals and differences among groups of students. As the term implies, **individual differences** are qualities that are unique; just one person has them at a time. Variation in hair color, for example, is an individual difference; even though some people have nearly the same hair color, no two people are exactly the same. **Group differences** are qualities shared by members of an identifiable group or community, but not shared by everyone in society. An example is gender role: for better or for worse, one portion of society (the males) is perceived differently and expected to behave a bit differently than another portion of society (the females). Notice that distinguishing between individual and group differences is convenient, but a bit arbitrary. Individuals with similar, but nonetheless unique qualities sometimes group themselves together for certain purposes, and groups unusually contain a lot of individual diversity within them. If you happen to enjoy playing soccer and have some talent for it (an individual quality), for example, you may end up as a member of a soccer team or club (a group defined by members' common desire and ability to play soccer). But though everyone on the team fits a "soccer player's profile" at some level, individual members will probably vary in level of skill and motivation. The group, by its very nature, may obscure these signs of individuality.

To begin, then, we look at several differences normally considered to be individually rather than group based. This discussion will necessarily be incomplete simply because individual differences are so numerous and important in teaching that some of them are also discussed elsewhere.

Individual styles of learning and thinking

All of us, including our students, have preferred ways of learning. Teachers often refer to these differences as **learning styles,** though this term may imply that students are more consistent across situations than is really the case. One student may like to make diagrams to help remember a reading assignment, whereas another student may prefer to write a sketchy outline instead. Yet in many cases, the students could in principle reverse the strategies and still learn the material: if coaxed (or perhaps required), the diagram-maker could take notes for a change and the note-taker could draw diagrams. Both would still learn, though neither might feel as comfortable as when using the strategies that they prefer. This reality suggests that a balanced, middle-of-the-road approach may be a teacher's best response to students' learning styles. Or put another way, it is good to support students' preferred learning strategies where possible and appropriate, but neither necessary nor desirable to do so all of the time (Loo, 2004; Stahl, 2002). Most of all, it is neither necessary nor possible to classify or label students according to seemingly fixed learning styles and then allow them to learn only according to those styles. A student may prefer to hear new material rather than see it; he may prefer for you to explain something orally, for example, rather than to see it demonstrated in a video. But he may nonetheless tolerate or sometimes even prefer to see it demonstrated. In the long run, in fact, he may learn it best by encountering the material in both ways, regardless of his habitual preferences. Research has shown that presenting information to students in the format that they prefer does not significantly improve their learning of that information.

That said, there is evidence that individuals, including students, do differ in how they habitually think. These differences are more specific than learning styles or preferences, and psychologists sometimes call them **cognitive styles**, meaning typical ways of perceiving and remembering information, and typical ways of solving problems and making decisions (Zhang & Sternberg, 2006). In a style of thinking called **field dependence**, for example, individuals perceive patterns as a whole rather than focus on the parts of the pattern separately. In a complementary tendency, called **field independence**, individuals are more inclined to analyze overall patterns into their parts. Cognitive research from the 1940s to the present has found field dependence/independence differences to be somewhat stable for any given person across situations, though not completely so (Witkin, Moore, Goodenough, & Cox, 1977; Zhang & Sternberg, 2005). Someone who is field dependent (perceives globally or "wholistically") in one situation, tends to a modest extent to perceive things globally or wholistically in other situations. Field dependence and independence can be important in understanding students because the styles affect students' behaviors and preferences in school and classrooms. Field dependent persons tend to work better in groups, it seems, and to prefer "open-ended" fields of study like literature and history. Field *in*dependent persons, on the other hand, tend to work better alone and to prefer highly analytic studies like math and science. The differences are only a tendency, however, and there are a lot of students who contradict the trends. As with the broader notion of learning styles, the cognitive styles of field dependence and independence are useful for tailoring instruction to particular students, but their guidance is only approximate. They neither can nor should be used to "lock" students to particular modes of learning or to replace students' own expressed preferences and choices about curriculum.

Another cognitive style is **impulsivity** as compared to **reflectivity**. As the names imply, an *impulsive* cognitive style is one in which a person reacts quickly, but as a result makes comparatively more errors. A *reflective* style is the opposite: the person reacts more slowly and therefore makes fewer errors. As you might expect, the reflective style would seem better suited to many academic demands of school. Research has found that this is indeed the case for academic skills that clearly benefit from reflection, such as mathematical problem solving or certain reading tasks (Evans, 2004). Some classroom or school-related skills, however, may actually develop better if a student is relatively impulsive. Being a good partner in a cooperative learning group, for example, may depend partly on responding spontaneously (i.e., just a bit "impulsively") to others' suggestions; and being an effective member of an athletic team may depend on *not* taking time to reflect carefully on every move that you or your team mates make.

There are two major ways to use knowledge of students' cognitive styles (Pritchard, 2005). The first and the more obvious is to build on students' existing style strengths and preferences. A student who is field independent and reflective, for example, can be encouraged to explore tasks and activities that are relatively analytic and that require relatively independent work. One who is field dependent and impulsive, on the other hand, can be encouraged and supported to try tasks and activities that are more social or spontaneous. But a second, less obvious way to use knowledge of cognitive styles is to encourage more balance in cognitive styles for students who need it. A student who *lacks* field independence, for example, may need explicit help in organizing and analyzing key academic tasks (like organizing a lab report in a science class). One who is already highly reflective may need encouragement to try ideas spontaneously, as in a creative writing lesson.

3.2 Individual Differences: Creativity

Creativity is the ability to make or do something new that is also useful or valued by others (Gardner, 1993). The "something" can be an object (like an essay or painting), a skill (like playing an instrument), or an action (like using a familiar tool in a new way). To be creative, the object, skill, or action cannot simply be bizarre or strange; it cannot be new without also being useful or valued, and not simply be the result of accident. If a person types letters at random that form a poem by chance, the result may be beautiful, but it would not be creative by the definition above. Viewed this way, creativity includes a wide range of human experience that many people, if not everyone, have had at some time or other (Kaufman & Baer, 2006). The experience is not restricted to a few geniuses, nor exclusive to specific fields or activities like art or the composing of music.

Especially important for teachers are two facts. The first is that an important form of creativity is **creative thinking**, the generation of ideas that are new as well as useful, productive, and appropriate. The second is that creative thinking can be stimulated by teachers' efforts. Teachers can, for example, encourage students' **divergent thinking**—ideas that are open-ended and that lead in many directions (Torrance, 1992; Kim, 2006). Divergent thinking is stimulated by open-ended questions—questions with many possible answers, such as the following:

- How many uses can you think of for a cup?
- Draw a picture that somehow incorporates all of these words: cat, fire engine, and banana.
- What is the most unusual use you can think of for a shoe?

Note that answering these questions creatively depends partly on having already acquired knowledge about the objects to which the questions refer. In this sense divergent thinking depends partly on its converse, **convergent thinking,** which is focused, logical reasoningabout ideas and experiences that lead to specific answers. Up to a point, then, developing students' convergent thinking—as schoolwork often does by emphasizing mastery of content—facilitates students' divergent thinking indirectly, and hence also their creativity (Sternberg, 2003; Runco, 2004; Cropley, 2006). But carried to extremes, excessive emphasis on convergent thinking may discourage creativity.

Whether in school or out, creativity seems to flourish best when the creative activity is its own intrinsic reward, and a person is relatively unconcerned with what others think of the results. Whatever the activity—composing a song, writing an essay, organizing a party, or whatever—it is more likely to be creative if the creator focuses on and enjoys the activity in itself, and thinks relatively little about how others may evaluate the activity (Brophy, 2004). Unfortunately, encouraging students to ignore others' responses can sometimes pose a challenge for teachers. Not only is it the teachers' job to evaluate students' learning of particular ideas or skills, but also they have to do so within restricted time limits of a course or a school year. In spite of these constraints, though, creativity still can be encouraged in classrooms at least some of the time (Claxton, Edwards, & Scale-Constantinou, 2006). Suppose, for example, that students have to be assessed on their understanding and use of particular vocabulary. Testing their understanding may limit creative thinking; students will understandably focus their energies on learning "right" answers for the tests. But assessment does not have to happen constantly. There can also be times to encourage experimentation with vocabulary through writing poems, making word games, or in other thought-provoking ways. These activities are all potentially creative. To some extent, therefore, learning content and experimenting or playing with content can both find a place—in fact one of these activities can often support the other. We return to this point later in this chapter, when we discuss student-centered strategies of instruction, such as cooperative learning and play as a learning medium.

4 Assessment

4.1 Principles of Assessment (Part 1)

Dr. Rosemary Sutton contributed to this module.

Basic Assessment Concepts

Best practices in assessing student learning have undergone dramatic changes in the last 30 years. In the past teachers often did not assess students' learning, they tested them on the knowledge and skills taught during the previous weeks. The tests varied little in format and students always did them individually with pencil and paper. Many teachers now use a wide variety of methods to determine what their students have learned and also use this assessment information to modify their instruction. In this module the focus is on the basic principles of assessments.

Assessment is an integrated process of gaining information about students' learning and making value judgments about their progress (Linn & Miller, 2005). Information about students' progress can be obtained from a variety of sources including projects, portfolios, performances, observations, and tests. The information about students' learning is often assigned specific numbers or grades and this involves measurement. **Measurement** answers the question, "How much?" and is used most commonly when the teacher scores a test or product and assigns numbers (e.g. 28 /30 on the biology test; 90/100 on the science project). **Evaluation** is the process of making judgments about the assessment information (Airasian, 2005). These judgments may be about individual students (e.g. should Jacob's course grade take into account his significant improvement over the grading period?), the assessment method used (e.g. is the multiple choice test a useful way to obtain information about problem solving), or one's own teaching (e.g. most of the students this year did much better on the essay assignment than last year so my new teaching methods seem effective).

The primary focus in this module is on **assessment *for* learning** , where the priority is designing and using assessment strategies to enhance student learning and development. Assessment for learning is often **formative assessment** , i.e. it takes place during the course of instruction by providing information that teachers can use to revise their teaching and students can use to improve their learning (Black, Harrison, Lee, Marshall & Wiliam, 2004). Formative assessment includes both **informal assessment** involving spontaneous unsystematic observations of students' behaviors (e.g. during a question and answer session or while the students are working on an assignment) and **formal assessment** involving pre-planned, systematic gathering of data. **Assessment *of* learning** is formal assessment that involves assessing students in order to certify their competence and fulfill accountability mandates. Assessment of learning is typically **summative** , that is, administered after the instruction is completed (e.g. a final examination in an educational psychology course). Summative assessments provide information about how well students mastered the material, whether students are ready for the next unit, and what grades should be given (Airasian, 2005).

Types of Assessment

There are many different ways to categorize assessments, some of which we addressed earlier in the module. These include the relationship between the test and instruction (formative vs. summative), the rigor of the assessment procedures (formal vs. informal), the type of student performance desired (maximum vs. typical), the type of test items used (supply vs. selection), whether time is a factor in evaluating performance (speed vs. power), how the test is administered (individual vs. group), how the test is scored (objective vs. subjective), and how grades are assigned (norm referenced vs. criterion referenced). We previously addressed the first two qualities: the relationship between the test and instruction and the rigor of assessment procedures. Assessments can be given during instruction in order to provide feedback to the student and teacher about learning, **formative assessment** , or at the end of instruction as a final evaluation of what was learned, **summative assessment** . The development, administration and scoring of an assessment can be highly structured and systematic, **formal assessment** , or have little structure and be unsystematic, **informal assessment** (Linn & Miller 2005).

Another method of classifying assessments is based on the type of student performance a teacher is trying to evaluate. We can assess our students' **typical performance** , their ability on an average day with no preparation like in a pop quiz. Or, we can assess their **maximum performance** , their peak performance given ample time to study and prepare for the assessment as in a final exam (Linn & Miller 2005).

In addition to classifying assessments based on the type of performance a teacher wants to assess, we can classify assessments based on the way students show their knowledge of information. Specifically, do we want students to recognize information or recall information? An assessment containing **selection** questions asks student to recognize the correct answer that is provided in a list of options. These types of questions include multiple choice, true/false, and matching. **Supply** questions are questions that require students to recall the answer from memory without alternatives being provided – such as in short answer or essay items (Linn & Miller 2005).

The next two methods of classifying assessments relate to the administration of the test. The first is whether or not the amount of time it takes to complete the assessment is important. In a **speed test** the amount of time it takes a person to complete the assessment is important. These tests usually contain a large number of questions and a short time limit. These assessments are often used to measure fluency, or someone's ability to complete simple tasks automatically and quickly (e.g. simple addition or letter identification). In a **power test** the amount of time it takes to complete the assessment is not important. However, this doesn't mean that there isn't a time limit, only that the time limit doesn't impact most students' performance on the exam. For instance, Mr. McMorris, a 5th grade teacher, may give his students 1 hour to complete a 30 question multiple choice end of chapter exam in science. While this test has a time limit, virtually every 5th grade student can complete 30 multiple choice questions in under one hour without rushing (Linn & Miller 2005).

The other method of classifying assessments related to administration is whether the test can be given to more than one person at a time. In an **individual assessment** the teacher must give each student the exam one-on-one. For instance, high school foreign language teachers often assess students' oral language fluency through one-on-one oral exams. In a **group assessment** the teacher can give the exam to multiple students at the same time. The vast majority of tests you have taken in school are group assessments because the entire class takes the test at the same time (Linn & Miller 2005).

The last two methods of classifying assessments deal with the grading. The first deals with the amount of interpretation that is required in scoring. An **objectively scored** assessment contains questions that require no interpretation on the part of the grader. For instance, on a multiple choice test the option selected is either correct or incorrect. In **subjectively scored** assessments the grader must interpret the response given by a test taker to determine its level of correctness. For instance, in an essay exam there are numerous ways to phrase the same correct answer. The grader must read the test taker's answer and determine to what extent the answer meets the requirements of the question (Linn & Miller 2005).

Once the individual items on an assessment have been scored, the students must be assigned grades. Grades can be assigned using one of two methods – norm referencing or criterion referencing. In a **norm referenced** test, a student's grade is based on how his or her performance compares to other students who took the same exam. For instance, Ms. Tang, a high school math teacher with a class of 10 students, may decide to assign the student who does the best on the algebra exam an A, the next 2 highest scoring students Bs, the middle 4 scoring students Cs, the next 2 highest scores Ds, and the lowest performing students an F. You will notice that there is no mention of the number of questions each student answered correctly, only the relationship between their overall performance and that of the other students in the class. All of the students could have answered 90% or more of the questions correctly or none of the students could have answered more the 50% of the questions correctly (Linn & Miller 2005).

In a **criterion referenced** test, a student's grade is based on how his or her performance compares to an absolute standard. For instance, a B being awarded to students who answer 80%-89% of the questions correctly on an exam. In Ms. Tang's example, she could have implemented a criterion referenced grading system by awarding any student who answered 90%-100% of the questions correctly an A, 80%-89% correct a B, 70%-79% correct a C, 60-69% correct a D, and less than 60% correct an F. You should notice that there is no mention of the number of students who will earn each grade. All of the students could earn As or they could be evenly distributed across the letter grades (Linn & Miller 2005).

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4.2 Principles of Assessment (Part 2)

The primary author of this module is Dr. Rosemary Sutton.

Reliability

Reliability refers to the consistency of the measurement (Linn & Miller 2005). Suppose Mr. Garcia is teaching a unit on food chemistry in his tenth grade class and gives an assessment at the end of the unit using test items from the teachers' guide. Reliability is related to questions such as: How similar would the scores of the students be if they had taken the assessment on a Friday or Monday? Would the scores have varied if Mr. Garcia had selected different test items, or if a different teacher had graded the test? An assessment provides information about students by using a specific measure of performance at one particular time. Unless the results from the assessment are reasonably consistent over different occasions, different raters, or different tasks (in the same content domain) confidence in the results will be low and so cannot be useful in improving student learning.

There are 3 ways to assess the reliability of an assessment – Test-retest, equivalent forms, and internal consistency. **Test-retest** reliability evaluates a test's consistency over time. In order to evaluate test-retest reliability, a teacher would compare students' performance on the same set of questions given at two points in time (e.g. two weeks apart). The **equivalent forms** method (also called parallel forms or alternate forms) of evaluating reliability compares students' performance on two versions or forms of the same test. The **internal consistency** method of evaluating reliability is the only method that can be used with a single administration of an assessment. Internal consistency evaluates the consistency of students' responses within a single administration of a test. One of the simplest ways to evaluate the internal consistency of a test is the **split-half method** . In this method, a teacher compares students' scores on two halves of the test (usually odds vs. evens) (Linn & Miller 2005).

The Test-retest, equivalent forms, and internal consistency methods of evaluating reliability address the test itself. **Interrater reliability** addresses the grading of assessments. Specifically, it addresses the question: Would scores have been different if a different teacher had graded the test? In order to evaluate interrater reliability a teacher compares the scores that two different graders give the same answers to a question. Interrater reliability is only a concern for subjectively graded items, since these items require graders to make interpretations (Linn & Miller 2005).

Obviously we cannot expect perfect consistency. Students' memory, attention, fatigue, effort, and anxiety fluctuate and so influence performance. Even trained raters vary somewhat when grading assessment such as essays, a science project, or an oral presentation. Also, the wording and design of specific items influence students' performances. However, some assessments are more reliable than others and there are several strategies teachers can use to increase reliability.

First, assessments with more tasks or items typically have higher reliability. To understand this, consider two tests: one with five items and one with 50 items. Chance factors influence the shorter test more than the longer test. If a student does not understand one of the items in the first test the total score is very highly influenced (it would be reduced by 20 percent). In contrast, if there was one item in the test with 50 items that was confusing, the total score would be influenced much less (by only 2 percent). Obviously, this does not mean that assessments should be inordinately long, but, on average, enough tasks should be included to reduce the influence of chance variations. Second, clear directions and tasks help increase reliability. If the directions or wording of specific tasks or items are unclear, then students have to guess what they mean, undermining the accuracy of their results. Third, clear scoring criteria are crucial in ensuring high reliability (Linn & Miller, 2005).

Validity

Validity is the evaluation of the "adequacy and appropriateness of the interpretations and uses of assessment results" for a given group of individuals (Linn & Miller, 2005, p. 68). In plain language, validity refers to the accuracy of a test to measure what it is designed or intended to measure. For example, is it appropriate to conclude that the results of a mathematics test on fractions given to English Language Learners accurately represents their understanding of fractions? Obviously, other interpretations are possible. For example, that the immigrant students have poor English skills rather than mathematics skills.

It is important to understand that validity refers to the interpretation and uses made of the results of an assessment procedure not of the assessment procedure itself. For example, making judgments about the results of the same test on fractions may be valid if the students all understand English well. Validity involves making an overall judgment of the degree to which the interpretations and uses of the assessment results are justified. Validity is a matter of degree (e.g. high, moderate, or low validity) rather than all-or none (e.g. totally valid vs invalid) (Linn & Miller, 2005).

Three sources of evidence are considered when assessing validity – content, construct and criterion. **Content validity** evidence is associated with the question: How well does the assessment include the content or tasks it is supposed to? For example, suppose your educational psychology instructor devises a mid-term test and tells you this includes chapters one to seven in the textbook. Obviously, all the items in the test should be based on the content from educational psychology, not your methods or cultural foundations classes. Also, the items in the test should cover content from all seven chapters and not just chapters three to seven – unless the instructor tells you that these chapters have priority.

Teachers have to be clear about their purposes and priorities for instruction before they can begin to gather evidence related to content validity. Content validation determines the degree that assessment tasks are relevant and representative of the tasks judged by the teacher (or test developer) to represent their goals and objectives (Linn & Miller, 2005). It is important for teachers to think about content validation when devising assessment tasks and one way to help do this is to devise a Table of Specifications. A Table of Specifications identifies the number of items (i.e. questions) on the assessment that are associated with each educational goal or objective.

Construct validity evidence is more complex than content validity evidence. Often we are interested in making broader judgments about students' performances than specific skills such as doing fractions. The focus may be on constructs such as mathematical reasoning or reading comprehension. A construct is an abstract or theoretical characteristic of a person we assume exists to help explain behavior. For example, we use the concept of test anxiety to explain why some individuals when taking a test have difficulty concentrating, have physiological reactions such as sweating, and perform poorly on tests but not in class assignments. Similarly, mathematical reasoning and reading comprehension are constructs as we use them to help explain performance on an assessment. Construct validation is the process of determining the extent to which performance on an assessment can be interpreted in terms of the intended constructs and is not influenced by factors irrelevant to the construct. For example, judgments about recent immigrants' performance on a mathematical reasoning test administered in English will have low construct validity if the results are influenced by English language skills that are irrelevant to mathematical problem solving. Similarly, construct validity of end-of-semester examinations is likely to be poor for those students who are highly anxious when taking major tests but not during regular class periods or when doing assignments. Teachers can help increase construct validity by trying to reduce factors that influence performance but are irrelevant to the construct being assessed. These factors include anxiety, English language skills, and reading speed (Linn & Miller 2005).

A third form of validity evidence is called criterion-related validity. Criterion related validity is the extent to which a student's score on a test relates to another measure of the same content or construct. Criterion related validity is further delineated into two sub-types depending on when the other measure is given to students. If the other measure is given at the same time, we use the term **concurrent** validity. If it is given at some point in the future, we use the term **predictive validity** . Selective colleges in the USA use the ACT or SAT among other measures to choose who will be admitted because these standardized tests help predict freshman grades, i.e. they are high in the predictive type of criterion-related validity.

Reference

Linn, R. L., & Miller, M. D. (2005). Measurement and Assessment in Teaching 9th ed. Upper Saddle River, NJ: Pearson.

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